CIVIL ENGINEERING

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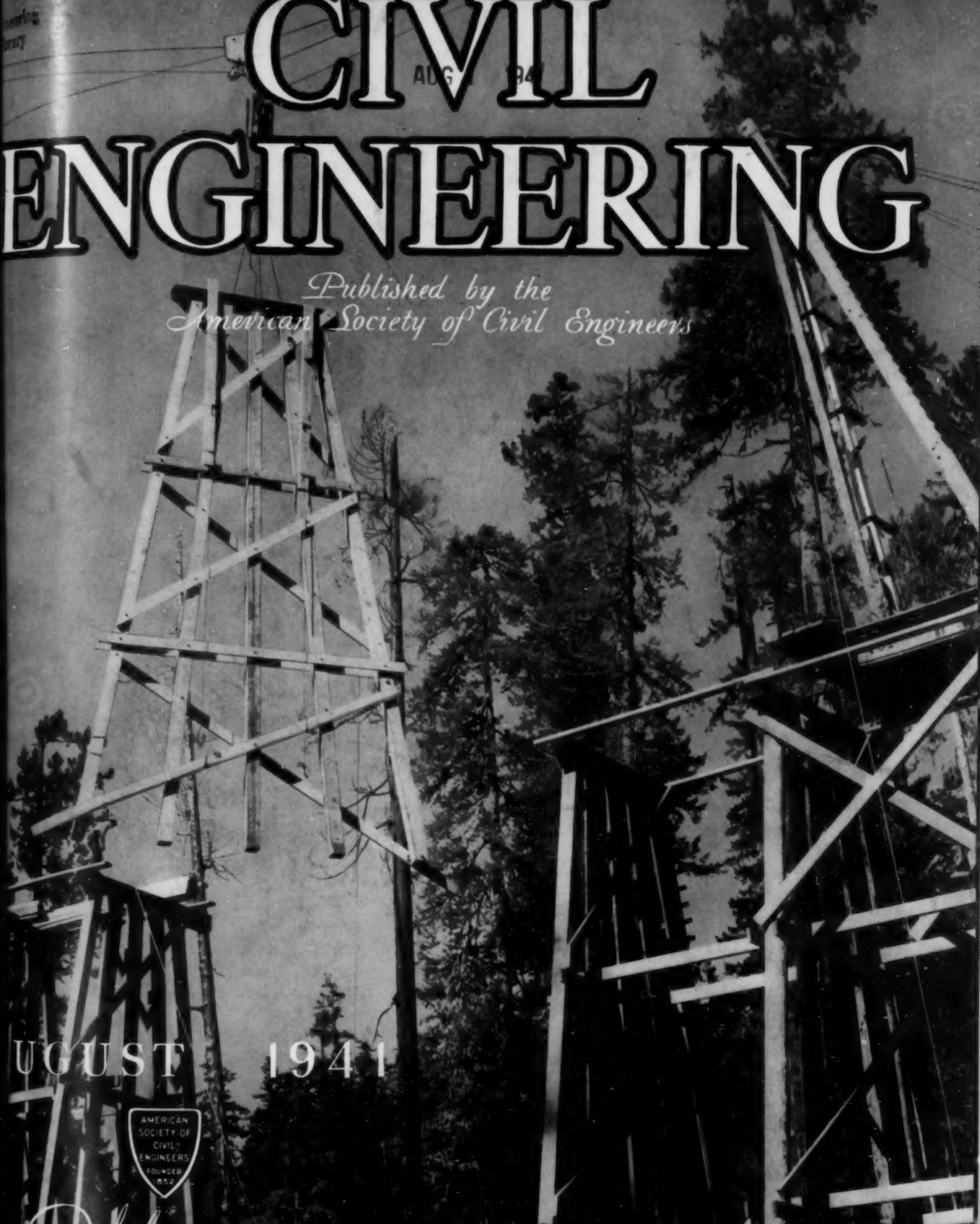

UGUST 1941

Volume 11
Number 8

BAIRD CREEK BRIDGE
Cowlitz County, Washingto


BIDS ASKED

SKYWARD
Pit River Bridge Pier

Among Our Writers

FREDERICK H. FOWLER (Stanford U., A.B., '05) has served as Director of the Society and is now President. Since 1922 he has maintained a consulting practice in San Francisco and for the past few months has been Chief of the Design Section of the Civil Engineering Division of the Construction Quartermaster Department, U.S. Army.

J. A. GIVEN (Iowa State, B.C., '08) has worked on location and construction for the Ozark and Cherokee Central and Muskogee Southern railroads, and on construction and maintenance for the Union Pacific and Southern Pacific Co. During the World War he was Captain, Major, and Lieutenant Colonel in the Corps of Engineers and served for 11 months with combat divisions in France. At present he is Location Division Engineer for the Southern Pacific Co.

E. W. DIGGES (V.P.I., B.S. in M.E., '18) was in private engineering work 1918–1929, specializing in real estate developments and office building construction. Since 1929 he has been with the U.S. Engineer Department—for the past 5 years as chief of the Flood Control Division of the Baltimore Engineer District, on design and construction of flood control works in the Susquehanna River basin.

WALTER J. RYAN (Cornell, C.E., '06) is a native of Nebraska who has spent all his professional career in the Pacific Northwest. After completing college he went to Washington with the Northern Pacific Ry. and spent several years in railroad and irrigation work. In 1914 he was employed by the Weyerhaeuser Timber Co. to open a new operation at Snoqualmie Falls, Wash., and he has been with that company ever since.

THOMAS M. ROBINS (U.S. Military Academy, B.S., '04; U.S. Army School graduate, '08; honor graduate, Command and General Staff School, '23; graduate Army War College, '26) has had continuous service in both the military and civil work of the Corps of Engineers. He has been Division Engineer for the South Pacific Division, Division Engineer for the North Pacific Division, Assistant Chief of Engineers, and is now Senior Member of the Board of Engineers for Rivers and Harbors.

FRANCIS M. BARON (U. of Ill., B.S., '35; M.S., '36; Harvard U., S.D., '39) has been assistant in the civil engineering departments at the U. of Ill. and at Harvard. Since 1939 he has been assistant professor of civil engineering at Yale.

F. M. VAN AUKEN (Ohio State U., B.Arch., '30) holds a School Medal of the American Inst. of Architects and has been engaged in building and highway construction for a number of years. Since 1933 he has been associated with the Corps of Engineers, U.S. Army, and at present is chief of the Soils Laboratory at Denison, Tex.

W. S. FOSTER (Iowa State, C.E., '33) spent 6 years with the Iowa State Highway Commission as inspector and instrumentman. Since 1939 he has been with the Stanley Engineering Co.—first as resident engineer, and now as assistant engineer in charge of paving and street improvements.

JOHN W. GREENLEAF, JR. (Northeastern U., B.C.E., '30) was employed by X. Henry Goodnough, Inc., of Boston, 1930–1935, and was a member of the firm, 1935–1938. Since 1938 he has been with Metcalf and Eddy, of Boston.

T. T. MCCROSKY (Sheffield Scientific School, B.S. in C.E., '23; Louvain U., Belgium Ingenieur Constructeur, '25) has been in city planning and housing for the past 14 years. Previously he taught engineering mechanics and strength of materials at Yale. His city planning work has included 2 years with the National Government of China, on a comprehensive plan for Nanking, and 2$^1/_2$ years as Director of Planning in the Dept. of City Planning of New York. Since January 1941 he has been executive director of the Chicago Plan Commission.

P. S. O'SHAUGHNESSY (U. of Calif., B.S., '33) has been with The Panama Canal since 1934—first on the Madden Dam hydraulic test program, and at present in the Hydraulics Section of the Special Engineering Division which is in charge of the Third Locks Project.

MARTIN R. HUBERTY (U. of Calif., B.S. '20; Stanford U., Engineer, '34) served with the A.E.F. as a mechanical engineer in the Air Service. He has been at the U. of Calif. since 1921 teaching courses in irrigation and working on problems of water supply, water costs, and water requirements of plants.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

The Society in a National Emergency

By Frederick H. Fowler

President of the American Society of Civil Engineers

The leader of a great national engineering society in an era of world convulsion has the unique opportunity to observe and evaluate current events. From such a vantage point President Fowler here gives the results of his wide survey. After striving for many years to capitalize peace, the engineer has turned to "all-out" efforts now characterized as "total war." What the Society has accomplished and what great forces now guide its progress are also explained. This paper is briefed from the President's Annual Address as given before the Society's Convention in San Diego, Calif., July 23, 1941. The complete address will appear in the forthcoming "Transactions."

NOWHERE more clearly than in California is it evident that engineering has been practiced since earliest times. From the sunny calm of Spanish colonial days to the advent of the single-track railroad and, more recently, to the building of the mighty Hoover Dam, the engineer has been preeminent. Until a few decades ago, his fullest energies were concentrated on the development and betterment of an arid land. Only during the first World War did the program change from building for constructive purposes to building for destruction.

To End War?—But even then we visualized a definite end to strife, since the cry in 1917 was that we were waging a "war to end war." My faith in this slogan was somewhat shaken when, on a week-end leave from training camp, I chanced to open a translation of Cicero's oration on Scipio Africanus Minor, and read therein something to the effect that: "Scipio, by destroying our two great adversaries, Carthage and Numantia, ended war for all time."

Today, a glance will show that neither by the efforts of Scipio Africanus in the second century B.C. nor by our own of 1917–1918 has war been ended. In fact, a survey of our immediate surroundings, the country as a whole, and the entire world will show that we have progressed—or from a humanitarian standpoint, have retrogressed—to that most destructive of all things, the most modern of all martial inventions, "total war."

By "total war" we do not merely mean that we concentrate on the enemy our heaviest battalions afield and our heaviest broadsides afloat. "Total war," it has been said, is the organization and exploitation of every resource and device, the employment of the energies of every individual within the warring state; it is by the demands of total warfare that today every mine, forest, field, and factory, and every man and woman in the country are being brought by an inevitable process into active service.

Destructive Effort.—Progress in this new type of war is measured by units of destruction rather than units of production. "Man-hours" of productive labor give way to "division-days" of annihilation—the destructive work of one army division for one day.

Poland, we are told, was conquered within 30 days at the modest figure of 1,050 "division-days." France, the Netherlands, and Belgium fell after 45 days at an expenditure of 9,000 "division-days." It is clear that such destruction can be accomplished in so brief a time only in a mechanized age, and a mechanized age must needs be an engineering age. It therefore behooves us to make some appraisal of what we as individuals, and as members of the Society as a whole, have accomplished in preparation for a continued "all-out" effort for our part in "total war."

Construction Advisory Committee.—The Society's own activities in the present emergency have been in brief as follows. Realizing, in the early part of 1940, that the country's preparedness program and the engineers' part therein were at least a year behind, we, together with the other Founder Societies, the American Institute of Architects, and the General Contractors Association, initiated cooperation with the Army and Navy Muni-

tions Board. On May 6, 1940, this hitherto informal organization was formally appointed by the War and Navy Departments as the Construction Advisory Committee of the Army and Navy Munitions Board. It consisted of the heads of the various organizations represented, and five out of its six members were also members of the Society. The Advisory Committee, so constituted, has with one exception since confined itself to questions of policy, and concentrated largely on establishment of proper conditions of contract and employment.

These particular activities were initially directed toward the passage of proper legislation; the elimination of agency contracts to manufacturers to design, construct, and operate; establishing proper forms of construction contracts approved for management; segregation of engineer-architect contracts from construction contracts; the elimination of competition in fees; establishing regulations and fees for all subcontracts; establishing the principle of utilizing existing engineering and architectural firms instead of expanding existing government organization; urging the widest geographical distribution of technical and construction contracts to avoid overloading and favoritism; preventing undue migration of technical and construction personnel; insuring adequate compensation for engineers and architects under various classifications; and insuring adequate fees for consulting services.

Material Accomplishments.~The work of the Advisory Committee was largely completed by the end of 1940. Summarizing the results very broadly, it was found possible to extend to other branches of the government beneficial legislation already passed for the Navy. Agency contracts could not be entirely eliminated. Proper forms of contract were developed in the Construction Division, Office of the Quartermaster General, and in the U.S. Engineer Department of the Army; these had already been established in the Navy. Separate engineering and construction contracts were established at the outset in the Army and later, by change of policy, in the Navy. Little trouble was encountered in competition for fees. Regulation of subcontracting was secured in the Army and, although initially unsatisfactory, it was later remedied in the Navy. Building up of government organizations has been limited very generally, but some existing forces of considerable size have not been reduced. A far more general geographical distribution of work has been secured.

It is probable that no abnormal migration of technical personnel has taken place, although men are snapped up as soon as released and it is difficult to recruit a force for any new project. Adequate compensation for engineers and architects is in effect; the adequacy of fees depends upon the department, and upon the extent to which fees have been scaled down below those shown by the normal curves originally established.

Much credit goes to the Navy for pioneer legislation covering the "cost-plus-a-fixed-fee" type of contract, which greatly facilitated the work of the Advisory Committee; studies started as early as 1938 in connection with the construction of the Pacific island bases finally became law by Act of Congress, April 25, 1939. The success in handling this work by the Navy has proved an invaluable precedent in later extension to other departments.

Problem of Fees.~From time to time complaint has been raised as to the inadequacy of fees in defense construction and, particularly, against the requirement that a waiver of all claims under unfinished projects must be signed before a new contract can be awarded. However, leading members of the Society, long in responsible charge of large projects, are not only willing and anxious to take work under the later reduced schedules, but readily sign the waivers that are required. The fact is that it is our war; we feel a patriotic and proprietary interest in it. Our own members have been in charge of construction on more than 80% of the newly constructed divisional centers as well as many other projects of great magnitude and varying types.

Also Civilian Protection.~Even in these hectic days not all of the Society's efforts are bent on the total ruin of the enemy, but some are directed to passive civilian defense, lest the enemy totally ruin us. I have reference to the work of our very efficient National Committee on Civilian Protection in War Time. Work and organization of the main committee are paralleled in most of our Local Sections and its activities are increasing in momentum.

There has been an orderly progress in the work of the committee and in October of last year, at a meeting called by the Secretary of War within the War Department, arrangements were made for informal cooperation. Later, the War Department created the National Technological Civil Protection Committee, consisting of one member each from eleven national societies, or organizations, together with a contact member from the War Department. In recognition of his effective and pioneer work, Chairman Binger of the Society's committee was very properly appointed chairman of the national committee, which, it was announced, "would assist the War Department in technological matters relating to the collection and evaluation and dissemination of information of value in protection of civilians and civilian institutions in time of war."

Civil Engineers in a New World.~It is clear that the engineer is enmeshed in total war. The civil engineer builds plants in which the mechanical engineer manufactures shells, tanks, and all other war paraphernalia, and the greater the perfection they evolve in their career of destruction, the sooner will they be able to return with their fellowmen to peace and the pursuit of happiness. However, whether the peace that follows this war will be the same calm peace, and the happiness, the same kind of happiness that we have known in years gone by, yet remains to be seen.

Gone are the sunny sleepy days of the Mission Fathers in California; gone are the constructive days of our own pioneer ancestors. All around we see ample signs of military and naval efficiency in the heavens above, on the earth beneath, and in the waters that surround the land.

Devastating but Interesting.~We live in a tragic world of total war; fewer are killed but more are enslaved. We cannot for a moment complain, however, that we live in an uninteresting age. Each day a new act in the world drama unfolds, and in each act the engineer will play to the full his part.

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Railroad Relocation and Construction Around Shasta Dam—Part I

By J. A. Given, M. Am. Soc. C.E.
Location Division Engineer, Southern Pacific Company, Redding, Calif.

Railroad location across country as rugged as Shasta County, California, is an experience granted to few engineers. The relocation around Shasta Dam required the construction of twelve tunnels and eight steel bridges as well as such details as 200-ft cuts. Furthermore, it was necessary to guard against the possibility of landslides when Shasta Lake is filled. In this paper Mr. Given, the locating engineer, tells of the reconnaissance, preliminary, and final surveys. In a subsequent paper, to be published in an early issue, he will deal with construction methods.

The building of Shasta Dam will create an artificial reservoir which will back up the water of the Sacramento, Pit, and McCloud rivers, submerging a portion of the existing railroad and state highway in that area. Alternate preliminary surveys were made for the railroad relocation. One on the westerly side of the Sacramento River, known as the West Side Survey, was made in 1930; and another, on the easterly side of the river, known as the East Side Survey, was made in 1935. The present paper will deal entirely with the East Side Survey, as that was the one finally adopted. Construction work was started in the fall of 1938 and will be completed in the spring of 1942, thus requiring about three and a half years. The reconnaissance covered a wide area with several possible routes, involved a general investigation of the major streams, a study of possible bridge sites, a general idea of the tunnels, and a sufficient knowledge of the country to avoid, as far as possible, areas subject to landslides (particularly when saturated with reservoir water). The work was done with compass, barometers, and such maps as were available. The government had excellent topographical maps of the reservoir area, while the California State Highway commission furnished maps and profiles which were very helpful for the work in the vicinity of the highway. In this connection it may be pointed out that it is one thing to build a railroad through a country "as is," but quite a different matter when it becomes necessary to consider the effect of a reservoir with a maximum depth of water of 400 ft, as at Pit River.

The key to the location of the so-called "East Side" line was obviously the crossing of the Pit River. Reconnaissance was made of some twelve miles of the river to determine possible bridge sites, and the choice was finally narrowed down to three. Geologists were then called in and asked to examine the three sites and report on the character of the foundations that would be encountered, and on the likelihood of major landslides occurring in the proximity of the bridge when the mountain sides were saturated with reservoir water.

The first site was condemned for the reason that there would be a major landslide at the north abutment when the reservoir had saturated the ground. It was found that the second site would provide excellent foundations, although in some cases excavation through the overburden would be as much as 80 ft deep, and that the third site would provide the same excellent foundations as the second with less overburden.

The second site was finally selected because the approaches were more accessible to both the railroad and the highway. This site is a short distance below the confluence of the McCloud and Pit rivers (Fig. 1), and the first thought was to locate the railroad so that it would closely follow the McCloud River. However, probable slide conditions near the mouth of the McCloud made it advisable to follow Azelle Creek north from Pit River, and to break through the ridge at Tunnel No. 3, thus entering the McCloud country through the backdoor.

It was seen that further to the north, opposite Smithson, the route first investigated would traverse an area subject to heavy slides, when saturated, thus necessitating a change of route to avoid treacherous ground. The reconnaissance developed the feasibility of a location with maximum 4° 00′ curves and maximum grades of 0.9% for northbound trains and of 0.5% for southbound trains (the direction of preponderating tonnage). These grade rates were finally adopted with a 10% reduction at all sidings and at least a similar amount through tunnels and for a maximum train length approaching the tunnels from the downhill end.

In order to keep the tunnels to a minimum it was evident that, coming out of Redding, the line would have to continue to climb after passing the Pit River, instead of paralleling the water surface. This feature resulted in establishing a summit near the head of O'Brien Creek some three and a half miles north of the Pit River Bridge site.

When the reconnaissance was completed, a survey party was organized to make the preliminary survey. As the Pit River Bridge was to be a joint structure, with the railroad on the lower deck and the highway on the upper deck, it was agreed that the Highway Commission would stake a tentative bridge tangent at the Pit River in a position mutually agreed upon. The railroad party started at the summit and proceeded north, following

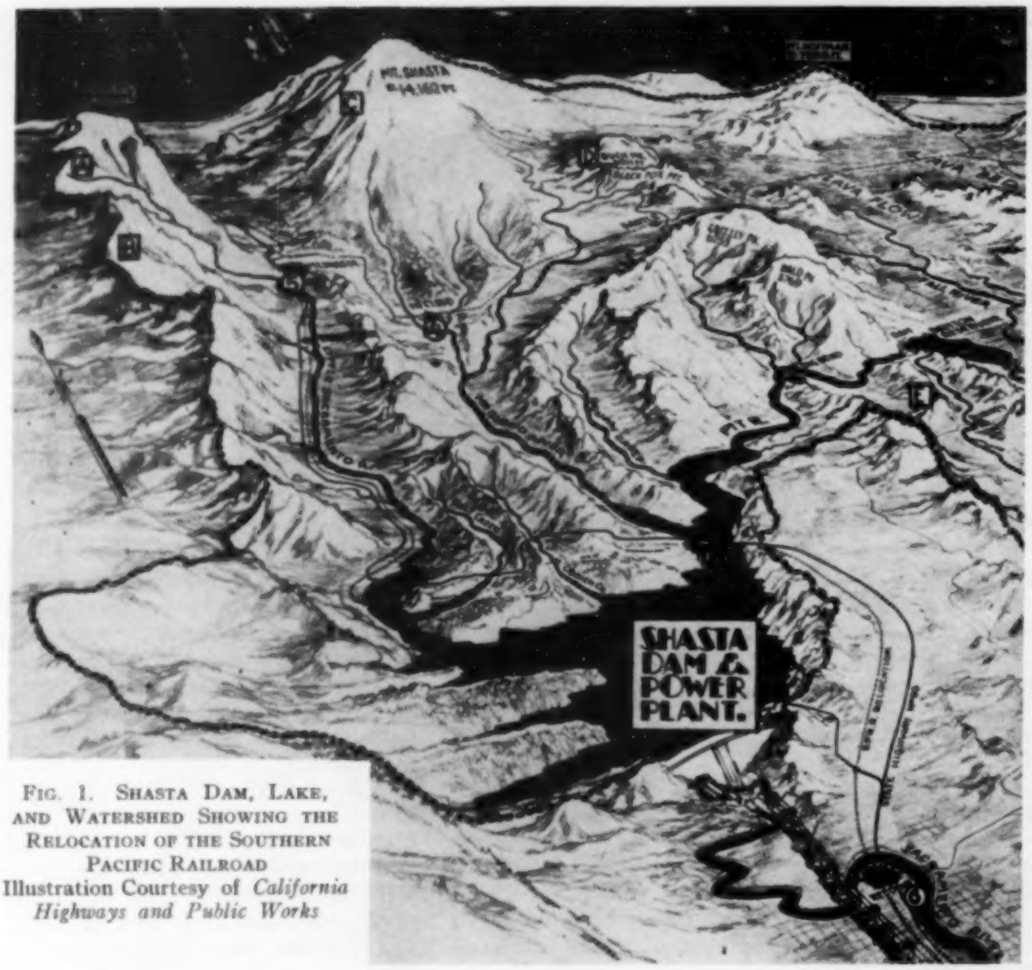


FIG. 1. SHASTA DAM, LAKE, AND WATERSHED SHOWING THE RELOCATION OF THE SOUTHERN PACIFIC RAILROAD
Illustration Courtesy of *California Highways and Public Works*

O'Brien, Halfway, and Salt creeks to and across the Sacramento River above Pollock, then continuing north and paralleling the river to the upper end of the reservoir about a mile downstream from Delta. Alternate lines were considered through the area where the relocated line would necessarily fall on sidehill country above the operated line. The survey finally selected involved the use of light adverse grades in order to locate as much as possible of the new line on comparatively flat country, which greatly reduced the cost of construction and future maintenance.

Having completed the survey to the north the party returned to the initial point at the summit and then proceeded south to a connection with the operated line at Redding. Here again alternate surveys were necessary to determine the most feasible way of breaking through the ridge between the Sacramento River drainage and Boulder Creek.

The junction with the operated line at the north end near Delta was selected at such a point that future filling in of the river bed, at the upper end of the reservoir, with sand, gravel, and boulders would not create a high-water condition detrimental to the new line. The junction at Redding was chosen so as to cause the least interference with established industries and to minimize the purchase of valuable city property.

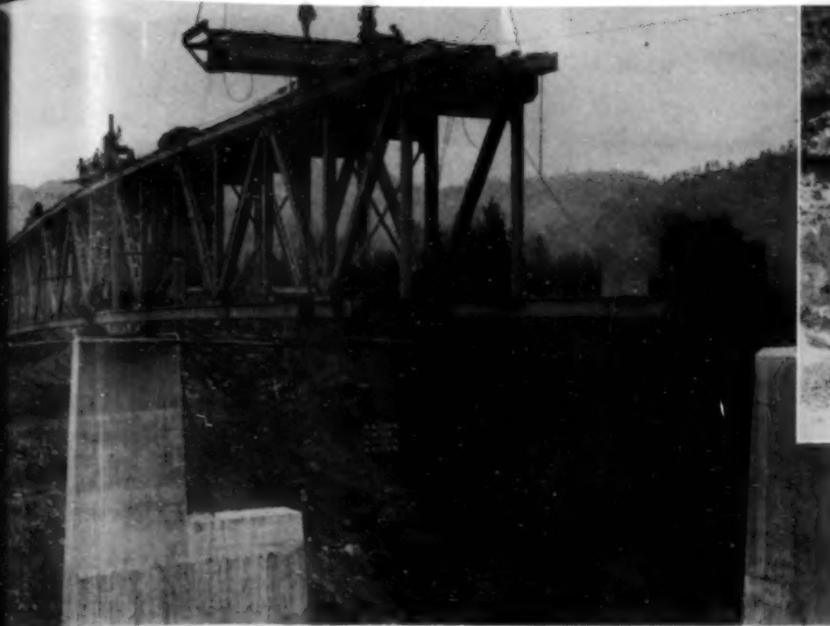
Through most of the difficult country a scout party, consisting of an expert instrumentman and two rodmen, preceded the transit party by several days. Much of this territory was overgrown with a high dense brush, and in places visibility was very limited. The scout party worked along paths, old roads, and open spaces, availing themselves of high bare spots where they could "shoot" into otherwise inaccessible places. They used stadia methods entirely and located sufficient control points both as to position and elevation so that a study of their plotted notes, together with the engineer's knowledge of the terrain, enabled him to project a preliminary line. The transit party was then furnished with predetermined bearings and distances to follow through blind country. Where curves were indicated, the transit party ran what were approximately chords to the curve, thus keeping the preliminary survey reasonably close to what would be the final line and limiting the width of topography that it was necessary to take. About 95% of the survey attained this ideal; for the remainder it was necessary to secure additional topography.

Following the scout party came the usual transit and level parties. The transit line was a traverse, accurately run as to distance and angles, to serve as a framework on which to build the topography and to be used as a check on the field location, frequent ties later being made between the two surveys. The level party took elevations at all survey stakes, at breaks in the ground, and at all stream beds, establishing bench marks at frequent intervals.

A topographical party, consisting of a topographer and two rodmen, followed the level party. Each morning this group was furnished with a tracing showing what part of the preliminary line was to be covered that day. The tracing also showed the preliminary traverse and all elevations previously determined by the level party. The topographer used a portable drafting board and plotted contours (10-ft intervals in steep country, and 5-ft intervals in flatter country) together with such features as stream beds, roads, and buildings, for a sufficient distance each side of the line of survey to supply information for a paper location. The party used a tape, rod, compass, and clinometer. High-water marks were noted and a preliminary estimate made of the size of culvert required, together with a notation of the type of foundations to be expected.

All this information was plotted by the field draftsman. Transit notes were plotted on a master map, scale 1 in. = 200 ft, by calculated latitudes and departures. Level notes were put on profile paper, and topographical sheets were transferred to the master map, and inked in. The locating engineer studied the maps plotted during the day to keep the survey from "wandering."

After the field parties had finished, the transitman and topographer accompanied the locating engineer over the



Construction of Slope Paving at a Typical Tunnel Portal

Doney Creek Bridge in Process of Construction

mpleted Second Crossing of Sacramento River Above Redding

Sidehill Cut 228 Ft High Immediately West of Tunnel No. 9, Showing Benches at 60-Ft Intervals

truction of First Crossing of the Sacramento River Above Redding

O'Brien Creek Bridge—Piers Under Construction

line, making a further detailed study of the size required for each culvert. The maximum annual precipitation is 68 in. at Redding and 118 in. at Delta, with occasional winters of 2 ft of snow at Redding and 6 ft at Delta.

This group also made notes on the geological formations as indicated by surface conditions and excavations, where nearby highway or county roads existed, as well as on character of the brush, timber, and similar features.

Due to the excellent highway and county roads the entire job was unusually accessible, and all parties on preliminary surveys and location worked out of Redding; during construction, the parties worked out of Toyon (a government town), which was centrally located in regard to the railroad work as well as that at Shasta Dam.

As the master map progressed a paper location was made. After an elevation at the summit was selected, the projection was made both ways downhill (the same as the surveys), using 0 + 00 at the summit and carrying the stationing progressively in both directions. Inasmuch as the bridges and tunnels would, obviously, be the largest items of construction expense, the paper location was made to minimize them. Location is affected by the relationship between the unit cost per cubic yard of excavation and cost of overhaul. A cubic yard taken out of required excavation in a cut, if placed in a fill within the limit of free haul, obviously performs double duty at no extra cost. When the expense of overhaul equals the cost of a cubic yard borrowed from alongside, it is no longer economical to extend the haul. With wheelbarrows the economical haul was perhaps only a hundred feet; with carts and slip scrapers it increased. Horse-drawn wheeled scrapers still further expanded it, and with modern carryalls, drawn by Diesel-powered caterpillars, the limit has been extended to better than a mile. Thus the locating engineer of today has a horizon far beyond that of his predecessor of a generation ago.

Any paper location in difficult country is a series of trial-and-error projections. An alinement is first drawn, in pencil, and a profile plotted by scaling along such line to locate points at which it crosses contours, stream beds, and so forth. A study of data thus developed often leads to changes in alinement until, finally, a satisfactory line is projected on the map and final profiles are drawn. Cross sections made up by scaling at right angles to the projected line to contours were likewise made, and yardage was computed. The final profile showed the yardage of each cut and fill and was accompanied by a mass diagram showing the directions and limits of haul.

A condensed profile scale (1 in. vertical = 100 ft, and 1 in. horizontal = 1,000 ft), together with a map (scale 1 ft = 1,000 ft) of the alinement of the paper projection, was prepared.

From data furnished by the field party, the office of the chief engineer of the railroad prepared tentative plans and estimates for the various bridges. Finally, a preliminary report was made, outlining the physical and operating characteristics of the proposed line. This was accompanied by a tentative estimate of construction costs. These surveys were made by the railroad's forces, while the U.S. Bureau of Reclamation made the field location and handled all subsequent work in connection with construction.

The field location followed closely the paper location, except where advantage could be taken of the fact that further studies had indicated the desirability of lowering the high-water level of the reservoir 30 ft less than was contemplated at the time of the preliminary survey. At O'Brien Creek further studies indicated that the viaduct originally planned was unduly expensive, and an alternate line was adopted which added some distance and curvature, but reduced the cost of construction.

A geologist accompanied the locating engineer over the line, classifying the formations and studying particularly drainage problems involving springs, seepage, or unusual ground-water conditions.

Near Redding the formation is sand, gravel, and boulders, but within a short distance this changes to sandstone and shales. Near Pit River, diorite and diabase are encountered. Still further north shales and slate with some porphyry and limestones are found, and near the upper end of the line there are lava caps—the result of ancient flows from the now extinct volcano of Mt. Shasta.

The route finally selected leaves the operated line at Redding and immediately crosses the Sacramento River by means of a steel bridge. This bridge not only crosses the defined river channel but also an area subject to overflow at extreme high water, and likewise provides grade separations in two places with a county road. Leaving this bridge, the line follows a north and northeasterly direction on an ascending grade through a rolling, hilly country for $12^1/_2$ miles, and in general skirts the head of the drainage of a number of large creeks.

Breaking through a ridge in Tunnel No. 1 (2,719 ft in length), the line enters the Shasta Reservoir area, crosses Montgomery Creek on a fill and passes beneath another ridge in Tunnel No. 2 (2,691 ft in length), where it enters upon the Pit River Bridge, crossing what will become an arm of the reservoir. Continuing north and still on an ascending grade, the line follows Azelle Creek for half a mile and bores through another ridge in Tunnel No. 3 (1,864 ft long), crosses Turntable Creek on a fill, and enters Tunnel No. 4 (856 ft in length), which is closely followed by Tunnel No. 5 (1,900 ft in length).

The line then hangs on a steep mountain side for another mile to Tunnel No. 6 (745 ft long), and a half mile further on enters Tunnel No. 7 (1,688 ft in length). The summit, which is 18 miles north of Redding, is just north of this tunnel. The line then descends, following a general northwesterly direction and crossing O'Brien Creek on a steel bridge. It passes through Tunnel No. 8 (898 ft in length), and follows a steep sidehill country for the next mile, crosses Halfway Creek on a fill, and then enters Tunnel No. 9 (1,610 ft long). A few hundred feet north of this tunnel Salt Creek Bridge is reached. For the next mile and a half the line extends through rugged country, crossing Indian Draw on a 100-ft fill and entering Tunnel No. 10 (2,243 ft in length). Just outside the tunnel, at the north end, Fall Creek is crossed on a fill, and a half mile further on the Sacramento River is crossed for the second time on a steel bridge.

For the next three and a half miles the line swings to the north, roughly paralleling the reservoir. For this distance it goes through comparatively easy country, the only large stream being Doney Creek, where a deep gorge is crossed on a steel bridge. After this there are two more miles of difficult construction where the relocated line was built in steep sidehill country above the line now operated, the difference of elevation varying from 120 ft to zero. In this distance there are two more tunnels—No. 11, which is 941 ft long, and No. 12, with a length of 916 ft—and the Sacramento River is crossed twice more on steel bridges. The latter of these two structures is close to the junction with the operated line at the upper end of the reservoir, and this junction is 30.1 miles from the one at Redding.

Construction aspects of the relocation project will be described in a subsequent issue.

Determination of Flood-Control Benefits

A Proposed Basis for Evaluating Tangible and Intangible Losses from Expected Floods

By Edward W. Digges, Assoc. M. Am. Soc. C.E.
Principal Engineer, U.S. Engineer Office, Baltimore, Md.

Where the results justify the cost, flood-control structures may be undertaken as a partnership arrangement between the Federal Government and a state, subdivision of a state, or other responsible local agency. This means that the expected resulting benefits must be evaluated in terms of dollars and cents prior to construction. In his paper which was presented before the Baltimore Meeting in April, Mr. Digges gives a very comprehensive analysis of this difficult problem, not as a final solution but as a principle that has been tested with reasonably satisfactory results.

There are two phases to the determination of annual flood-control benefits: first, estimating the damages that result from individual floods of various magnitudes; and second, estimating the average annual value of such benefits based upon flood expectancy. These two phases will be discussed in that order, with principal consideration given to the former.

For the purpose of this analysis, flood-control benefits will be considered as the value of all losses prevented by protective works, the enhancement in property values due to protection, and the value of the psychological effect upon the people protected. It is obviously unwise as a business proposition to expend funds for flood protection unless the investment will return the full amount expended. It is desirable, therefore, to estimate benefits expected from the construction work with an accuracy comparable to that of the estimates of cost. The same careful consideration should be given to this as is given to the design, or any other features relating to flood control. While some types of damages and benefits are difficult to evaluate, they should be analyzed as carefully as their relative magnitude merits.

All flood losses may be grouped in two general classes—tangible and intangible. Tangible losses may be defined as those susceptible to measurement in monetary terms within reasonable limits of accuracy. Conversely, intangible losses may be defined as those to which monetary values cannot be assigned with any measurable degree of accuracy. Again, tangible losses may be subdivided into direct and indirect. Direct losses will be considered as the physical damage to property, or the cost of restoring property to its pre-flood condition and usefulness. Indirect losses will be considered as those resulting primarily from the interruption of normal business operations and services.

In evaluating direct damages it has been found convenient and satisfactory to consider the following general classifications:

1. *Industrial.* Damages to manufacturing plants, equipment, and stock.
2. *Commercial.* Damages to buildings, fixtures, and stock of commercial establishments.
3. *Residential.* Damages to buildings, home furnishings, lawns and other improvements, and appurtenances.
4. *Highways.* Damages to roads, bridges, and other highway improvements outside of urban areas; damage to highway transport equipment and merchandise in transit.
5. *Railroads.* Damages to roadbeds, bridges, equipment, and merchandise in transit.
6. *Public and Semi-Public.* Damages to streets, bridges, parks, schools, churches, auditoriums, stadiums, theaters, and other similar structures.
7. *Utilities.* Damages to telephone, telegraph, and radio; gas, light, and power; water and sewage; street car and city bus transportation.
8. *Agricultural.* Damages to farm property, including soil erosion, buildings, equipment, crops, and livestock.

Losses of the following types may be conveniently designated as indirect damages:

1. The cost incurred to alleviate hardships and suffering and to safeguard health; the cost incurred to reduce direct losses by the erection of temporary barriers, by the removal of merchandise and household goods to higher elevations, by providing for temporary housing of population and business, and by the increased cost of insurance.
2. Losses in payroll due to reduction of normal operations at place of employment, or the inability to secure labor, power, supplies, or other facilities because of flood conditions.
3. Losses to railroads, bus and truck lines, including commuter trade, fast freight and express transportation; losses incurred through extraordinary expenditures to reduce direct damages to structures and equipment; and the losses due to the maintenance of traffic over detours.
4. Loss of profits to certain business establishments because of lack of trade, or the delay required to replace stock and recondition equipment.

Flood damages may be estimated either by making a detailed survey of each property in the area affected, or by selecting representative samples and applying the results to similar properties in the remainder of the area. The selection of the type of survey will depend upon the size of the area and the frequency of the damage. Where damages are small and infrequent, great detail may not be warranted. But a detailed survey is desirable in

Downtown Wilkes-Barre, Showing How Certain Incremental Damages Result Immediately Upon the Flooding of Each Floor Level

Water Supply Tunnel Under Construction Kingston-Edwardsville Project Baltimore District

Same Construction Flooded by Toby Creek Two Months Later—Any Engineer Knows What This Means

AN EXAMPLE OF DIRECT FLOOD DAMAGE, NOT DIFFICULT TO EVALUATE

small areas where only a few properties of each type and class are subject to relatively frequent flooding. The sampling method may be employed in large areas having a great number of the same general type and class of property. The personnel engaged in the compilation of flood data must be thoroughly instructed as to the use to be made of the data, and must use uniform methods in its collection and classification. Types and classes of properties and of damages must be well defined and readily discernible to the investigator in the field.

Valuable information may be obtained from appropriate departments of state governments, heads of country and municipal governments, city engineers, local flood control committees, chambers of commerce, and private commercial and industrial interests throughout the areas affected. This information, together with that obtained from public hearings, serves as a basis on which a field investigation may be conducted. Interviews and physical inspection of flood damages will give reliable information regarding typical losses. Important commercial and industrial losses must be investigated individually and in detail.

The streams on which damages are to be surveyed are divided into rural reaches and damage centers for which separate data are desired. This division should be made in such a manner that damages from various floods will have a definite relation to flood stages measured at an established gaging station. Benefits may then be properly assigned to prospective local works, or to flood-storage dams if local protection is not justified. The stage relationship between the maximum probable flood, the greatest flood of record, and all previous noteworthy floods should be determined for each area. Other available data such as contour maps, aerial photographs, and bench marks will facilitate work in the field survey.

In addition to the collection of direct and indirect damage data for recent major floods, field estimates are made of the damages that would have occurred at higher and lower flood stages. These estimates are prepared for floods extending throughout the range from zero damage to that of the largest probable flood. The number of each type and class of building in the affected area, and the elevations of each basement, first floor, and second floor level are determined. Thus careful analysis is given the general profile of the flooded area. This is important because certain incremental damages result immediately upon the flooding of each floor level. Upon the flooding of one level damages may remain substantially constant until the next flood level is reached.

From the data obtained as described, stage-damage curves are prepared showing the relationship between flood stages and recurrent damages, both direct and indirect. Damages that may be expected from floods of various magnitudes can be read from these curves. Where crop damages are important, the preparation of stage-damage curves for various seasons may be warranted.

Flood-control benefits, like damages, may be classified as tangible or intangible. For convenience, tangible benefits may be subdivided into direct benefits, which result from reduction of direct damages; indirect benefits, which result from reduction of indirect damages; and property enhancement benefits.

Enhancement benefits represent the difference between the value of the land before flood protection and its value after such protection. An increase in property value may be expected in areas where development has been retarded by floods, or by the threat of flooding. The value of the land before protection is reflected by assessments and by sales. The enhancement of land values may be found by comparison with the value of lands in the immediate vicinity outside the flood plane, but similar in other respects. The annual value of such enhancement may be determined as the interest on a reasonable rate of increase in the value of the property.

There are many incidental benefits, predominately intangible, though often important, to which monetary values cannot be assigned. These include such items as safety to human life; assurances that normal business, cultural, and social activities will not be interrupted; esthetic benefits, such as the elimination of unsightly or otherwise objectionable conditions; and benefits to the national defense.

Considering the various types of damages and the many variable factors involved, it would be obviously impractical to arrive at a mathematically exact determination of total flood-control benefits. The degree of accuracy attained depends to a large extent upon the nature of the benefits, the relative importance of the tangible and intangible benefits in each problem considered, and the methods used in collecting and classifying the data. The estimate will be more comprehensive if each of the various classes of benefits are evaluated separately, clearly defined, and properly identified. An explanation of the method by which each estimate was prepared will materially assist those desiring to evaluate the accuracy and dependability of the total estimate or any of its parts. For instance, it would be misleading to assign large values to certain intangible and indeter-

FLOOD DAMAGE TO WILKES-BARRE RESIDENTIAL PROPERTY ALONG SUSQUEHANNA RIVER (LEFT) PREVENTED BY BUILDING OF DIKE WITH REVETTED SLOPE (RIGHT)

minate benefits without clearly indicating the reason and the basis on which such benefits were evaluated. The degree of accuracy may be considered in this sequence:

1. Evaluation of direct benefits.
2. Evaluation of indirect benefits.
3. Evaluation of the enhancement to property.
4. Evaluation of intangible benefits.

To illustrate the relative accuracy of estimating flood-control benefits, it may be assumed that the owner of a certain automobile was traveling through a flooded area when the machine was stranded and had to be abandoned. The owner in leaving it may have suffered from exposure, contracted pneumonia, and perhaps died.

In this instance the physical damage to the machine was a direct result of flood waters. It has a definite monetary value represented by the cost of repairs or the loss in market value, which can be readily determined. The estimated benefit that would result from the prevention of this direct damage would be of the first order of accuracy.

The loss of service of the automobile was a result of its non-usefulness during rehabilitation and was an indirect result of the flood waters. The loss and inconvenience may or may not have been great, depending upon the owner's need of the car. The benefit that would result from the elimination of this loss has a monetary value but cannot be evaluated as readily and accurately as the direct benefit. This estimated indirect benefit would be second in order of accuracy.

The area in which the machine was stranded may be enhanced in value if flood protective works are constructed. The new economic value of the area, which may be improved as a parking lot, or as a site for some other development, may be evaluated but with considerable uncertainty, depending upon its future use. Certain protected areas may undergo little or no enhancement in value because other development conditions, such as utilities, must be favorable. This type of benefit represents the third in order of accuracy.

The owner of the automobile may have suffered from exposure, partly due to the flood and partly to other causes, resulting in illness and finally death. While the owner's life may be evaluated, it is impractical to apportion the amount attributable to the flood and the amount that should be assigned to other natural causes. It is again obviously impractical to determine the compensation for suffering; or for the anguish and sorrow caused his family, or that caused other individuals. Estimates of benefits from the prevention of such damages are highly speculative, and if they are assigned monetary values the amount and the basis of evaluation should be definitely stated. Monetary estimates of such benefits represent the fourth in order of accuracy.

As previously stated, the second of the two phases in the procedure of evaluating flood-control benefits is estimating the average annual value of the benefits, based on flood expectancy. For this purpose a stage-frequency curve is obtained from flood records for each stream reach and each damage center by statistical methods. The derivation of the stage-damage curve has already been discussed. For each area the stage-damage and stage-frequency curves are combined graphically to produce a damage-frequency curve that shows for every year the percentage chance of occurrence of each increment of flood damage between the limit of damage from the largest probable flood and the limit of damage from the smallest annual flood. Average annual damages are obtained from this curve by integration. Curves of modified damages that would result after construction of flood-control works are similarly derived, and the modified average annual damages are likewise obtained. The difference between the original and the modified average annual damages represents the average annual benefits that may be expected to accrue to the flood-control works.

As annual damages and annual benefits computed in this manner are the average that may be expected throughout a very long period, actual annual damages and benefits for various shorter periods may vary widely. The occurrence of one or more very large floods within a relatively short time may increase the average damages for that period by a considerable amount. Since it is impossible to predict the year when such a flood will occur, the actual benefits that will accrue to flood-control works at any one locality cannot be exactly determined even if all other factors were known. The trend of development in the area being considered is another factor that will modify the average annual flood-control benefits.

Determination of benefits is a controversial subject and is as full of variables as the flood losses themselves. It is important that flood-control benefits be classified and evaluated as accurately as possible. Flexibility in the method of evaluating benefits is necessary because of differing conditions, but the fundamental purpose underlying each method is essentially the same.

In this discussion, the primary emphasis has been placed on the evaluation of benefits resulting from protection against specific floods. Many incidental factors are involved in the determination of annual flood-control benefits, but it is impractical to present all the procedure in detail in this brief analysis.

The Baird Creek Bridge

By W. J. Ryan, M. Am. Soc. C.E.

Chief Engineer, Weyerhaeuser Timber Company, Tacoma, Wash.

Loggers from the Atlantic to the Pacific have long been noted for their ingenuity in adapting local materials to any required service, and especially to bridge building. In this paper Mr. Ryan shows how the logger's ingenuity has been combined with sound engineering principles to produce an outstanding timber railroad bridge. Of unusual overall dimensions, this structure utilizes all the latest developments, such as sawn creosoted timbers, special metal connectors, concrete foundations, and design that anticipates wind stresses.

In the Douglas fir region, along the Pacific Coast in Oregon and Washington, structural material is available to the logging engineer in many forms. Decay-resistant red cedar furnishes mud blocks, piling, post, and decks for ballasted bridges. Young fir trees are available as posts or piling to lengths of 150 ft, and bridges of over 200 ft in height have been built with two decks. Sound logs of sufficient size to serve as girders are available for spans up to 80 ft and have been combined with shear connections for spans of over 100 ft. Where the logging is close to a sawmill, it is usually more satisfactory to have the timbers cut that are to be framed into a structure. This permits the use of creosoted material—important because bridges are being built for longer life.

One of the latest of these was recently completed in Cowlitz County, Wash., on a branch line of the Weyerhaeuser Timber Company railroad. This development is to open up timber in the Kalama River watershed, which is part of the area now planned for continuous operation to produce logs for the Longview mill. It is expected that the present cycle of cutting will require about 40 years, with the probability that after a lapse of 80 to 100 years logging will return to the same section.

The railroad was located to cross a canyon 230 ft below grade. As the canyon was occupied by a mountain stream, a 120-ft span was necessary to be safe from drift. The total length of the bridge required was 1,130 ft, of which 650 ft could be constructed of standard pile trestle without exceeding a cutoff height of 90 ft. For the remaining 480 ft, it was deemed best to use creosoted timber construction.

Rock occurred near the surface on one side of the canyon and for a short distance up the other side. For about a third of the length of the framed structure, rock was too deep to be reached by excavation. Foundations were prepared by sluicing the dirt off the rock and building concrete pedestals. Where it was not practical to expose the rock, creosoted piling was driven for the foundation. The arch abutments are five pedestals connected transversely by a reinforced concrete girder, designed to carry the load of adjoining bents, so that it will be possible to use it as a footing for jacks in making repairs or adjustments.

Spanning the site was an overhead cableway 1,100 ft long, used to transport all the material and equipment across the canyon. Concrete was placed by means of a bottom-dump bucket carried on this cableway. The concrete mixer was set under the approach trestle, which was driven as the first item of construction and provided bunkers for handling material to the concrete plant by gravity.

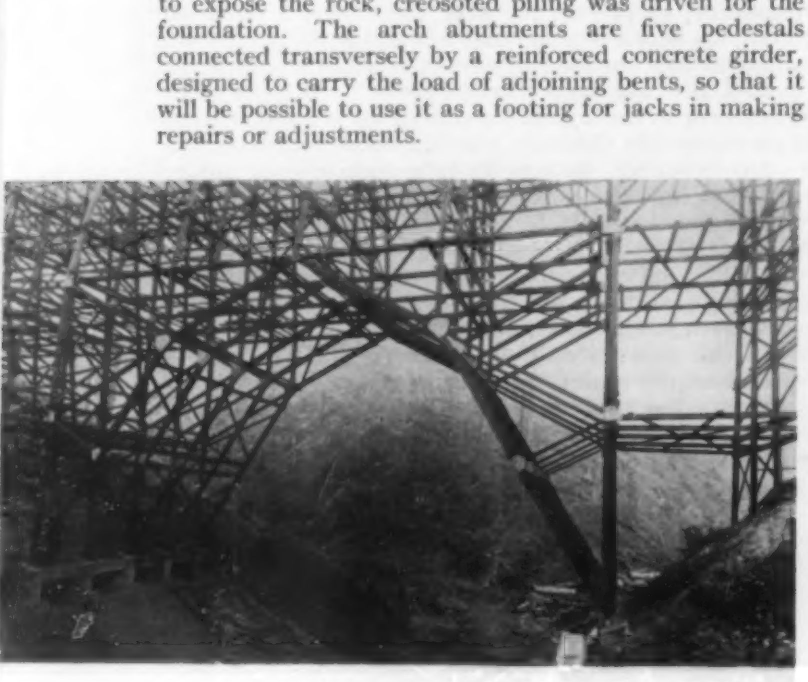
Under this cableway platforms were provided of sufficient size to allow for the assembly of the framed bents, and of the bracing in units of one span. The material was shipped from the framing yard in units and these were assembled and placed from the cableway. The bents on each side of the central arch were erected first, to the height of the arch; then the arch members were assembled in units and set in the hinges at the abutments and held by guys until the pins at the center hinge were driven and sufficient bracing placed to hold them in position. The four stories above the level of the top of the arch were erected by placing first the bent and then the intermediate bracing for the length of the bridge at one elevation before starting on the storey above.

Before designing the bridge, nine types of construction were considered. These are given in the following list, together with the cost estimate for each, made on the basis of cost per square foot on the side elevation of the bridge:

1.	Standard 5-pile cedar trestle with creosoted bracing and a leaning bent arch over the stream	$0.37
2.	Standard 5-pile cedar trestle, bents on 30-ft centers, cresosoted bracing	0.39
3.	Creosoted 5-pile timber trestle, bents on 16-ft centers	0.474
4.	Creosoted 5-pile timber trestle, bents on 30-ft centers, arch over stream	0.457
5.	Creosoted timber viaduct, with several column and truss designs for different spacings	0.516
6.	Concrete and timber viaduct, with hexagonal concrete towers and creosoted timber trusses	0.712
7.	Center section with concrete towers and creosoted trusses and pile trestle approaches	0.503
8.	All-steel viaduct (including transportation to site)	1.025
9.	Center section all-steel viaduct with pile trestle approaches	0.722

After a careful study of each type of structure, considering its advantages and disadvantages, it was decided to go ahead with the erection of a creosoted timber trestle with bents on 30-ft centers, a 120-ft three-hinged arch over the creek, and pile trestle approaches.

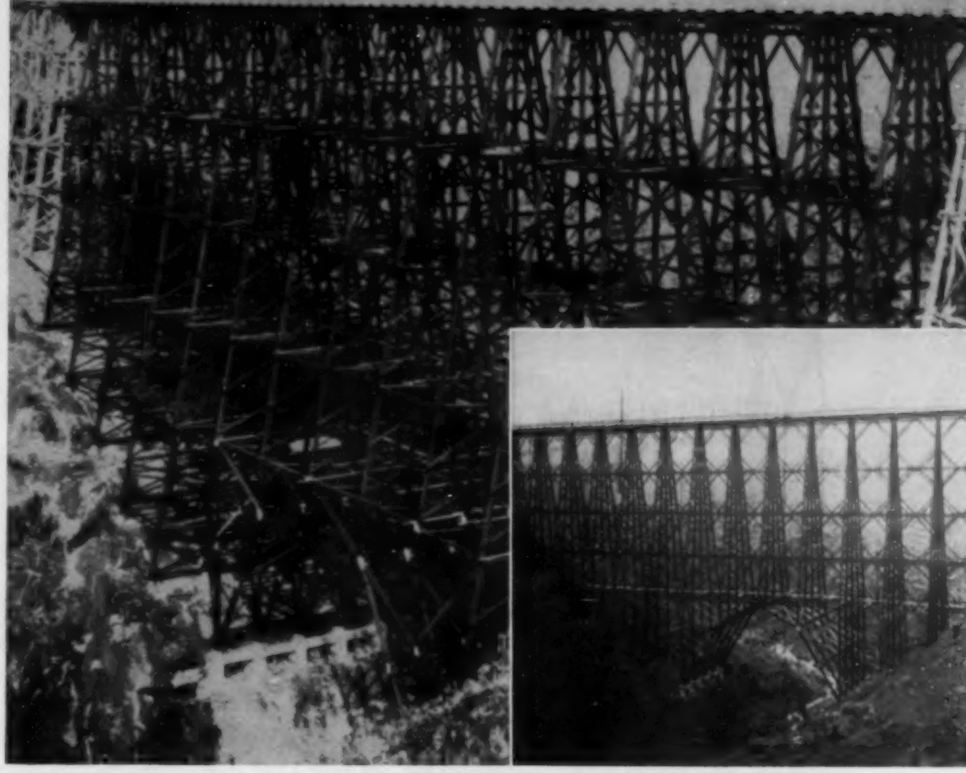
The structure is built of Douglas fir, structural grade. The members were all framed at the sawmill and shipped to the creosoting plant, where they were given a treatment of 8 lb per cu ft of a mixture of crude oil and creosote oil for the heavy timbers, and 10 lb per cu ft for the lighter members. On its return from the creosoting



Close-Up of Arch Over Baird Creek, Washington

plant, the material was sorted in the storage yard and loaded on cars in units for shipment to the site of the bridge. Templets were used for framing timbers. These were made from a full-scale layout. An effort was made to keep the parts of the structure uniform but it was necessary to use well over a hundred templets. Each one of these was detailed and drawings were made to be used by the framer and on the assembly platform.

The bridge was designed for Coopers E-55. Wind stresses, which were computed for 80-mile wind, resulted in the use of heavier timbers for the batter posts than for the intermediate posts of the bents. These bents were spaced 30 ft on centers to economize foundation costs, 30 ft being the maximum practical span for a sawn timber girder. The two outside posts of each bent were 14 by 14-in. timbers, the inside posts 12 by 14. Posts were carried continuously from foundation to cap. Galvanized steel sheeting was placed between the ends of the members and a splice plate applied to the outside.



Railroad Bridge 235 Ft High, 1,130 Ft Long, of Sawn Creosoted Timber
Inset Shows K-Bracing

The central span of 120 ft was made with five three-hinged arches, designed to carry the load from the five trestle bents. These arches were connected with steel gusset plates fastened to shear plates embedded in the wood, and connected at the hinges with built-up members carrying 4-in. pins. Bents were braced in the conventional manner. The longitudinal bracing between the bents was built flat and cross-braced to minimize the vibration. All the connections throughout the trestle were bolted and 4-in. split rings used except for the flat bracing on the longitudinal girts, which were spiked. Where bracing was applied to the creosoted piling it was fastened with spike grids.

The main compression joint in the arch was built by filling between two gusset plates with reinforced concrete. These joints were filled while the arch was assembled flat on the platform. This is the joint developed by John J. Gould, Assoc. M. Am. Soc. C.E., for use in the building trusses of the San Francisco Exposition buildings. Temporary bracing was placed on the side of the arch ribs while they were being picked from a horizontal position on the platform, transferred to the vertical, and placed in the structure.

Concrete Abutment with Three-Hinged Arches of 120-Ft Span

In this bridge the only bearing of load on the side grain of the timber below the caps occurs at the creosote pile foundation driven for the last four bents on the east end of the structure. There are nine piles in these bents, all capped, and on top of the caps steel channels are used to carry the posts.

Stringers consist of two chords of three members each, 12 by 31 in. These were laid level although both ends of the framed structure are on a curve. Superelevation was taken care of by framing the ties. The framed structure carries a walkway on each side with a hand rail.

The total time consumed in the erection of the structure was 100 days after the excavation and foundation were completed. During this time the contractor had an average of 25 men employed, including the pile-driver crew. Eight men worked continuously on the pile bents, 5 men on the assembly platform, and 4 men on the erection crew, together with an engineman and helper on the crane and an engineman and signalman on the sky line.

These men were employed 21 days on the erection of the framed bents, reaching a maximum of 8 bents in place during one 8-hour shift. There were some minor delays due to errors in framing or marking the pieces as framed. A simple system of marking for such a preframed structure is vital to efficiency in handling in the material yard and on the assembly platform.

The bridge was designed by the writer for the Weyerhaeuser Timber Company, with consultation with W. D. Smith of the U.S. Forest Service and T. K. May of the West Coast Lumbermen's Association. R. P. Conklin, logging engineer at the Longview Operation, placed the location. J. B. Firmin drew the plans. F. G. Jepson and A. L. Hall were inspectors. Timber for the framed section was preframed by Timber Structures, Inc., of Portland, Ore., at the mill of the Weyerhaeuser Timber Company at Longview, then creosoted at the plant of Pope and Talbot, Inc., at St. Helens, Ore. The Hart Construction Company of Tacoma and Longview, Wash., erected the bridge.

National Defense Construction Work

By Thomas M. Robins, M. Am. Soc. C.E.

Brigadier General, Corps of Engineers, U.S. Army; Assistant Chief of Engineers, Washington, D.C.

Of timely interest to the country at large and the engineering profession in particular, this paper by General Robins describes the War Department organization now dealing with the national defense construction program. This program, estimated to cost in excess of two billion dollars, will rank among the major tasks of all time. The speed with which it is being carried out testifies to the efficiency of the organization described by General Robins at the Baltimore Meeting.

Many government agencies having to do with construction are now concerned with national defense, and the work of all these agencies is being coordinated by the Office of Production Management. The government agencies most directly concerned with national defense construction are, of course, the War Department and the Navy Department. The Under Secretaries of War and Navy are charged with the direction of the construction programs of their respective departments. Construction work for the Navy is carried out by the Bureau of Yards and Docks, while Army construction, except that pertaining to coast defense and the Air Corps, comes under the Construction Division, Office of the Quartermaster General. Sea coast fortification work and Army Air Corps construction (except in Panama) are being handled by the Corps of Engineers. Since it would be impracticable to attempt to deal with the national defense construction program as a whole, this paper will be confined to the work of the War Department, especially in regard to organization and procedure.

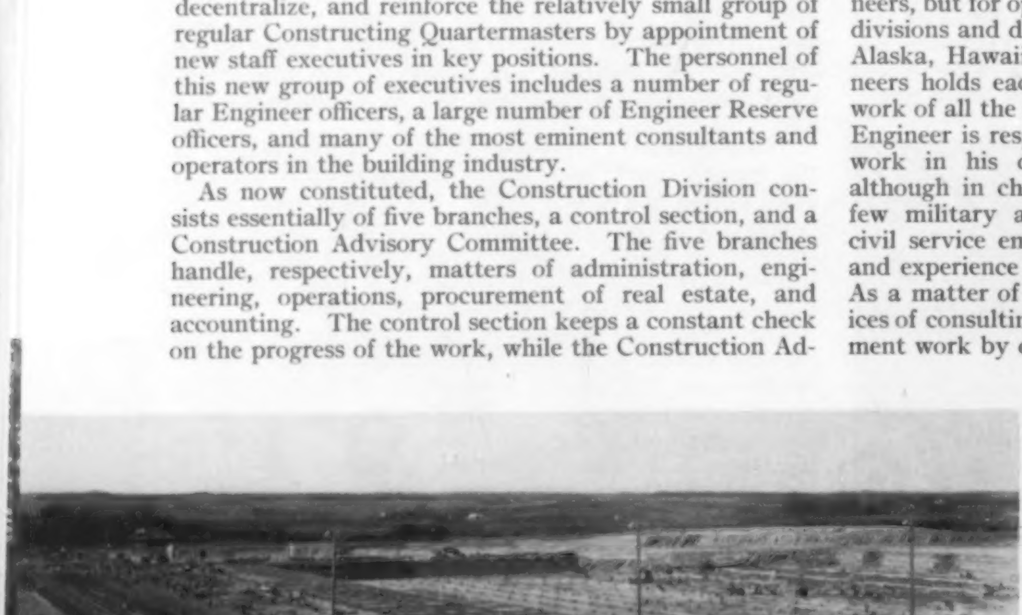
Prior to the present emergency the Construction Division, Office of the Quartermaster General, was a highly centralized unit geared to handle the relatively small volume of work required by the Army in time of peace. At the outbreak of the emergency, however, a great load was suddenly placed on this organization. The Division was forced to expand immediately to many times its original size and, at the same time, to initiate a tremendous amount of work, located all over the United States and its possessions, under heavy pressure for speed. Naturally it became necessary to reorganize, decentralize, and reinforce the relatively small group of regular Constructing Quartermasters by appointment of new staff executives in key positions. The personnel of this new group of executives includes a number of regular Engineer officers, a large number of Engineer Reserve officers, and many of the most eminent consultants and operators in the building industry.

As now constituted, the Construction Division consists essentially of five branches, a control section, and a Construction Advisory Committee. The five branches handle, respectively, matters of administration, engineering, operations, procurement of real estate, and accounting. The control section keeps a constant check on the progress of the work, while the Construction Advisory Committee passes on the qualifications of contractors and makes recommendations as to the award of negotiated contracts. For field work the country has been divided into nine zones corresponding roughly to the nine Corps Areas. Each zone is in charge of a Zone Constructing Quartermaster who supervises all projects in his territory, each project being in immediate charge of a Constructing Quartermaster. The Constructing Quartermasters have at their disposal the necessary administrative and engineering forces, while the Zone Constructing Quartermaster has a staff of specially qualified civilian experts.

National defense construction work in charge of the Corps of Engineers, U.S. Army, is being carried out with the same organization used for the improvement of rivers and harbors and flood control. This organization has for a great many years been a going concern handling a large volume of construction work of all kinds. It heads up for control in the Office of the Chief of Engineers, but for operation is decentralized into geographical divisions and districts covering the entire United States, Alaska, Hawaii, and Puerto Rico. The Chief of Engineers holds each Division Engineer responsible for the work of all the districts in his division, and each District Engineer is responsible to his Division Engineer for the work in his district. These divisions and districts, although in charge of regular Engineer officers with a few military assistants, are manned with permanent civil service employees of outstanding ability, training, and experience in administration as well as engineering. As a matter of course they avail themselves of the services of consulting engineers and understand how government work by contract should be handled.

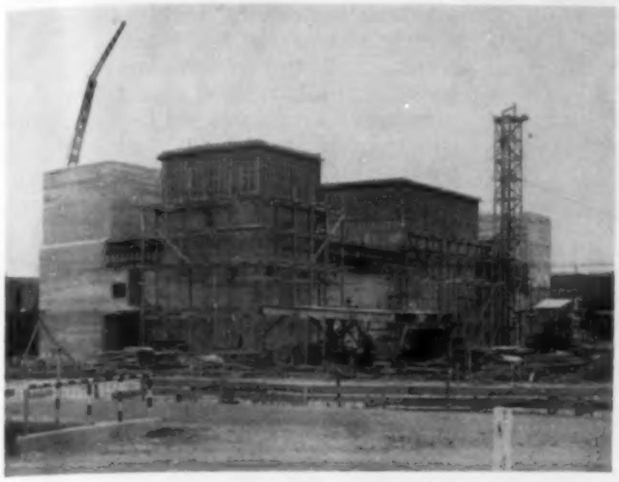
Hangar Construction, Ellington Field, Tex.

On account of its established organization and experience, the Corps of Engineers has been able to take on a large amount of national defense construction without undue expansion or interference with its regular work, civil or military. Anywhere throughout the country, wherever a defense project might be located, there was an Engineer District already organized and prepared to undertake the work



Fort Crook Aircraft Assembly Plant and Testing Field During Construction

When construction of Army air bases at Newfoundland, Bermuda, and in the Caribbean became necessary, the Corps of Engineers took the situation in its stride, creating a new division of four districts to cover the field. This was accomplished easily and quickly by



Erection of Engine Test Building, Duncan Field, Tex.

means of calling on the old districts on the mainland to furnish cadres.

Although a small amount of construction work, here and there, is being carried out by the Army on force account, or by purchase and hire as it is called in the Quartermaster Corps, the War Department construction program as a whole is predicated on doing the work by contract. In fact, it is obvious that this is the only way in which the situation could be met.

As in all military engineering, time becomes the factor of foremost importance in drawing up contracts for national defense construction. The elements of design, cost, and useful life which ordinarily take precedence must be subordinated to speed. This consideration must be kept constantly in mind if one is to get a true picture of the conduct of our preparedness program. It was realized fully by Congress when, at the outbreak of the emergency, laws were passed relaxing the ordinary statute requirements in regard to advertisement for bids and award of contracts to the lowest responsible bidder. Notwithstanding this action by Congress, the War Department has exercised a sound restraint both as to manner of award and form of contract, departing from ordinary procedure to adopt negotiated contracts only in so far as the exigencies of the service demanded.

TWO KINDS OF CONTRACTS AWARDED

Two kinds of negotiated contracts are being used—"lump sum" and "cost-plus-a-fixed-fee," the former being preferred. Negotiated lump-sum contracts are entered into without general advertisement and formal competitive bidding, but there is informal competition between a number of selected contractors in striking a bargain considered to be most advantageous to the government. The cost-plus-a-fixed-fee contract is resorted to only when work must be started before plans and specifications are sufficiently complete to form a basis for canvassing bids, or when the contingencies are such that a lump-sum contract would be a mere gamble.

Construction of Air Corps Hangar, Bowman Field, Ky.

Pouring Airfield Runway, Macon Flying School No. 1

Unfortunately, the cost-plus-a-fixed-fee contract is not well understood by the general public. There is a tendency to believe that, under this form of contract, the more the work costs the greater the profit to the contractor. Such is not the case. The fee is fixed at a certain sum before the contract is signed and cannot be increased unless the contractor is required to perform additional items of work not called for under the original contract. There is no relationship between the fee and the actual cost of the work. It should also be noted that the fee cannot be considered as clear profit to the contractor because his financing costs and general office expenses are not reimbursable under the terms of the contract. Neither can the contractor be reimbursed in full for traveling expenses on account of the general limitations on travel allowances for government employees.

FEE DETERMINATION

Under the law there can be no bonus or penalty provisions in a cost-plus-a-fixed-fee contract and the fee cannot exceed 6% of the estimated cost of the work.

The actual fee is determined after full consideration of (1) the degree of skill in engineering and management needed, (2) the extent of financing required, (3) services to be performed by the general office force, (4) amount and importance of the work to be subcontracted, and (5) estimated cost of the work and time required for completion. To give an idea of the fees being paid under War Department contracts it may be stated that architects and engineers receive on the average a fee amounting to three-fourths of 1% of the estimated cost of the work. For a \$1,000,000 construction contract the fee amounts to about 4%; for a \$5,000,000 contract, 3%; for a \$10,000,000 contract, $2^1/_2$%; and where the estimated cost of the work is in the neighborhood of \$30,000,000 the fee amounts to about 2%.

All defense contracts, where the consideration equals or exceeds \$500,000, must be cleared by the Office of Production Management. Use of the cost-plus-a-fixed-fee form of contract for Army work, regardless of estimated cost, must be authorized by the Under Secre-

JACKSON AIR CORPS PROJECT, JACKSON, MISS.

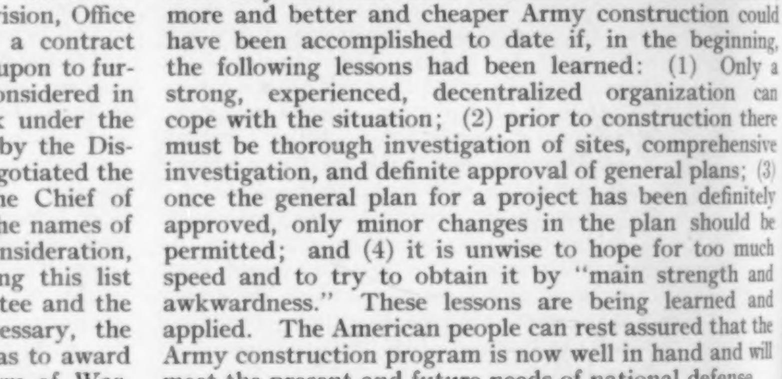
tary of War. All negotiated contracts on projects costing $500,000, or more, must be cleared by the Construction Advisory Commission, Office of the Quartermaster General, and approved by the Under Secretary of War. This procedure seems rather complicated, but my experience has been that the able engineers and business men serving in the Office of Production Management, in the office of the Under Secretary of War, and on the Construction Advisory Committee have, by their sound advice and untiring effort, rendered invaluable assistance in getting work under contract promptly with well-qualified contractors.

The procedure used by the Quartermaster Corps for handling applications by contractors for defense work differs somewhat from that followed by the Corps of Engineers. Applications for work under the Quartermaster Corps are received and filed by the Construction Advisory Committee, construction Division, Office of the Quartermaster General, and when a contract is to be negotiated this committee is called upon to furnish the names of the contractors to be considered in order of preference. Applications for work under the Corps of Engineers are received and filed by the District Engineer. When a contract is to be negotiated the District Engineer concerned submits to the Chief of Engineers, through the Division Engineer, the names of several contractors recommended for consideration, listed in order of preference. After clearing this list through the Construction Advisory Committee and the Office of Production Management, if necessary, the Chief of Engineers makes the final decision as to award subject to approval by the Under Secretary of War. In awarding negotiated contracts it is the established policy of the War Department to give preference to local concerns, if they are qualified to do the work.

Under the Army program some contracts have been made which cover both engineering and construction, but for most projects there are two contracts—one for architectural and engineering services and one for construction. For large projects the contractors often consist of a combination of several firms. Usually these combinations are formed prior to submitting applications for work. Sometimes it has been necessary for contracting officers to suggest certain combinations of firms in order to secure the needed financial strength, experience, and skill in engineering and management.

The extent and character of engineering services required for Army projects vary greatly. For cantonment construction with the standardized type of wooden buildings the engineering involved has to do mostly with layout and utilities, including water supply and sewage disposal. It must be done in a hurry and done right. Semi-permanent construction, of which there is considerable at depots and air bases, calls for both architectural and engineering services of high order. This class of work includes housing of different kinds, large shop buildings, hangars, wharves, soil stabilization for runways, drainage, and camouflage. Munitions plants, aircraft assembly plants, and construction at permanent posts afford a broad field for the best engineering talent. The entire Army construction program now under way is estimated to cost some two billion dollars. An undertaking of such magnitude is possible only because this country possesses an engineering profession outstanding in strength, ability, adaptability, and the will to do.

It seems a long time since September 1940 when large appropriations for Army construction first became available, but actually only ten months have passed. In this relatively short period much has been accomplished—much more than was accomplished during the eighteen months of participation by the United States in the first World War. Long hours of work and stupendous effort on the part of all concerned in the Army construction program have overcome many difficulties. Some obstacles that have stood in the way of efficiency and economy are inherent in the present state of the nation and may be considered unremovable. Nevertheless, more and better and cheaper Army construction could have been accomplished to date if, in the beginning, the following lessons had been learned: (1) Only a strong, experienced, decentralized organization can cope with the situation; (2) prior to construction there must be thorough investigation of sites, comprehensive investigation, and definite approval of general plans; (3) once the general plan for a project has been definitely approved, only minor changes in the plan should be permitted; and (4) it is unwise to hope for too much speed and to try to obtain it by "main strength and awkwardness." These lessons are being learned and applied. The American people can rest assured that the Army construction program is now well in hand and will meet the present and future needs of national defense



PHOENIX (ARIZ.) MILITARY AIRPORT

The Study of Earths—an American Tradition

By Francis M. Baron

Assistant Professor of Civil Engineering, Yale University, New Haven, Conn.

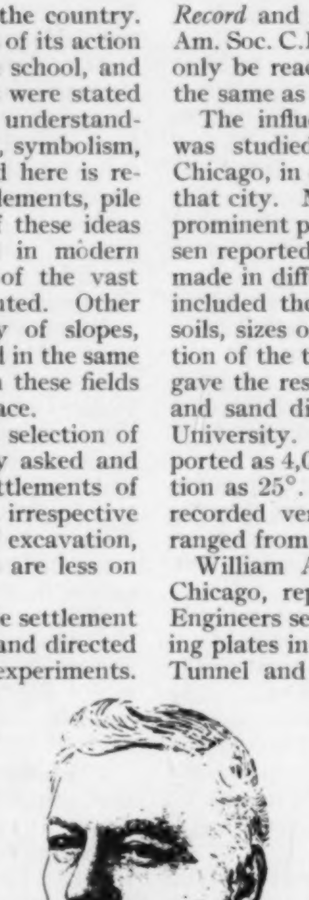
To a large number of engineers the news that soil mechanics "wasn't born yesterday" may have a familiar ring. In this paper Professor Baron gives perspective to the present renewed interest in this subject, which has deep roots in the firm foundations of the past. Although restricted by space limitations, he reviews important literature to remind engineers again that yesterday cannot be forgotten in the rapid pace of today. All illustrations are from the National Cyclopedia of American Biography.

At Yale University in the spring of 1940, at a conference of faculty and graduate students, the statement was made that the ideas current in the literature of soil mechanics are old, and in fact were clearly stated and readily available to American engineers before 1914. This statement encouraged the writer to make a study of the early American literature on the subject. The results will not surprise many older engineers, but they may interest the younger men, now engaged in this work all over the country.

The properties of earth and the principles of its action were studied intensively in the field, in the school, and in the laboratory before 1914. The results were stated in language remarkably simple, direct, and understandable without needless technical terminology, symbolism, and methodology. The evidence presented here is restricted to ideas on bearing capacities, settlements, pile foundations, and earth pressures; many of these ideas have somewhere or other been presented in modern literature as "new." Only a small part of the vast amount of evidence collected is here presented. Other topics of foundation engineering, stability of slopes, seepage, and road stabilization were reviewed in the same way. The same sort of evidence appears in these fields but discussion of it is omitted for lack of space.

Obvious and important questions on the selection of "permissible unit soil pressures" were early asked and studied. These included the effect on settlements of shape of loaded area, of size of loaded area irrespective of average intensity of pressure, of depth of excavation, and such questions as whether settlements are less on "hard" than on "soft" clay.

In 1851–1852 G. T. Beauregard studied the settlement of the Custom House in New Orleans, La., and directed the architect, John Roy, to make certain experiments. These were reported in a circular of the Office of the Chief Engineers, later reprinted in Van Nostrand's *Eclectic Engineering Magazine.* Thirty-five tests were reported, with a variation in size of loaded area from $^1/_4$ by $^1/_4$ in. to 2 ft by 2 ft; in loads from $1^1/_8$ lb to 29 tons; in average intensity of pressure from 1.3 to 14.5 tons per sq ft; in settlement from $^1/_8$ in. to 10 ft; in period of observation from three days to six months; and in depth of excavation from the surface to 8 ft below. One of the important conclusions was that "a larger surface sinks more than in proportion to its area."



G. T. Beauregard, Captain of Engineers, U.S. Army
Studied Settlement of New Orleans Custom House, 1851–1852

Randell Hunt, M. Am. Soc. C.E., referred in 1888 in the *Engineering News* to the tests of Roy and to a series of experiments conducted in France and reported in 1864. Hunt recognized that such experiments "are not generally of much value unless the area of the soil tested is of about the same extent as the base of the foundation to be placed upon it." He stated that "large areas of soft soil will not support as much weight, per unit of surface, as more limited areas of the same soil." Hunt presented also the hypothesis that a small pier settles less than a large pier with the same unit intensity of pressure, as the frictional resistance is proportional to the pier perimeter while the total pressure is proportional to the pier area.

In a lecture delivered at the Rensselaer Polytechnic Institute and published in 1891 in the *Engineering Record* and *Engineering News,* Francis Collingwood, M. Am. Soc. C.E., stated that "absolutely certain results can only be reached when the area tested is approximately the same as that to be built upon."

The influence of the area and depth of excavation was studied by various architects and engineers of Chicago, in cooperation with the building department of that city. Many tests were reported by them in several prominent periodicals in 1912 and 1913. J. Norman Jensen reported in 1913, in the *Engineering News,* five tests made in different places in Chicago. The reported data included the locations of the tests, descriptions of the soils, sizes of bearing areas, load per unit of area, duration of the tests, and settlements observed. Jensen also gave the results of some laboratory tests on "hardpan" and sand directed by O. H. Basquin at Northwestern University. The cohesion of the "hardpan" was reported as 4,000 lb per sq ft, and the angle of internal friction as 25°. In a triaxial compression test the ratio of recorded vertical pressure to recorded lateral pressure ranged from 3.39 to 5.58.

William Artingstall, Chief of Subway Engineers of Chicago, reported in 1912 to the Western Society of Engineers several tests made with different sizes of bearing plates in locations adjacent to the Van Buren Street Tunnel and allegedly each on the same type of soil. He said that in each case the load that would produce the same settlement was obtained. The calibrated readings of a dynamometer connected to the lever arm of a jackscrew were as follows: 8 tons per sq ft for a bearing 4 by 4 in., 12 tons for 6 by 6 in., 22 tons for 8 by 8 in., 32 tons for 8 by 12 in., and 49 tons for 12 by 14 in. The records of these tests are important as they apparently are not in accordance with the theoretical results of Boussinesq's solution and the theory of consolidation.

In 1905 the writer of a letter to the *Engineering Record* stated that he was able to load a concrete bed 15 ft wide 20% more per square foot than adjoining beds 6 ft wide, obtaining very nearly the same measured settlements. The editor commented on the distinction that engineers make between compressible foundations and those that yield sideways, and stated: "In the soils which yield sideways with or

without compression, the area of the footings and the extent to which the soil is confined laterally are of most importance."

Depth of excavation was early recognized as an important element in the selection of permissible unit soil pressures. Jules Gaudard said in 1878, and William J. McAlpine, M. Am. Soc. C.E., in 1884, in Van Nostrand's *Eclectic Engineering Magazine*, that observed settlements depended on the depth of excavation. J. W. Pearl, M. Am. Soc. C.E., stated in 1912 before the Western Society of Engineers that the deeper the foundation is placed, the more it will support safely, or the more uniform will be the settlement. Other writers also referred to the importance of the depth at which a structure is founded.

W. J. McALPINE, PRESIDENT OF THE SOCIETY, 1868–1869

Early Recognized Importance of Depth of Excavation, and Prepared Difficult Foundations for State House at Albany, N.Y.

The distinction between total load on a foundation bed and the load in excess of that carried prior to any excavation was pointed out by several engineers. This distinction was clearly stated in 1906 in an editorial of the *Engineering Record*, and by C. K. Mohler in 1912 before the Western Society of Engineers. The essential question was stated to be: How much can be safely added to the "virgin" load. An article in 1894 in the *Engineering News* on the foundations of the Tower Bridge, London, England, indicates computations in which the weight of the clay excavated and replaced by masonry was deducted from the load of the pier.

The possibility of loading every part of a foundation bed before construction, with considerably more than the maximum load, and long enough to insure exemption from further settlement, was discussed by Francis Collingwood in 1891.

There is evidence that settlements of structures were studied by American engineers before 1914. It was recognized that differential settlements and not total settlements may cause demoralization of a structure. The experiences related were many, and various possible causes of settlement were studied. Discussed were settlements from lateral flow of clays and sand, quicksand pockets, loss of stability, compression of a soft clay under a hard crust of earth, vibration, pumping from wells, and the squeezing out of water from clay.

Settlement caused by compression of a soft material under a hard crust of earth was discussed by Francis Collingwood in 1891 in the *Engineering Record*, by Randell Hunt in 1896 in the TRANSACTIONS of the Society, and by many engineers of Chicago.

Settlement allegedly caused by pumping of water from a well and by vibrations occasioned by machinery was reported in 1896 by Charles Sooysmith, M. Am. Soc. C.E., to the Society. It seemed reasonable to Sooysmith that "the water flowing through the sand made possible a slight readjustment of the particles, which settled into closer union under the vibration of the machinery in the building."

Particular consideration is given to several articles on settlement caused by the squeezing out of water from clays. These were published in a number of prominent periodicals, which included *Engineering News*, *Engineering Record*, *Journal of the Western Society of Engineers*, *Journal of the Association of Engineering Societies*, and the *Technograph* of the University of Illinois.

In an address delivered at the University of Illinois in 1892 (first published in the *Technograph* of that institution and later in the *Engineering News* and *Engineering Record*), Gen. William Sooy Smith, M. Am. Soc. C.E., discussed his observations of foundations in Chicago. He stated that loads of 1.25 to 2 tons per sq ft produce a small initial settlement within a few hours, due to compacting of the soil near the loads, and the squeezing out of water from the earth close to the loads. William Sooy Smith observed that buildings continued to settle months and years later, and that while initial settlements might be uniform, the progressive ones might eventually so differ as to cause serious cracks and demoralization in the structure. He stated:

JAMES B. EADS, M. AM. SOC. C.E.

Built Eads Bridge at St. Louis, Mo., South Pass Jetty of Mississippi, Diving Bells, and Dredges

"The slow progressive settlements result from the squeezing out of the water from the earth, as was clearly seen while the wells were sunk under the stage of the Auditorium for receiving the hydraulic cylinders used for operating the scenery. I sank these wells after the adjacent walls of the building were built. Some of them went to a depth of 24 ft below the footings of the foundations and only $4^1/_2$ ft from them. The weights resting on the soil amounted to 30 lb per sq in., or 4,320 lb per sq ft. I had made the borings and tests of the soil and knew the nature of the materials at different depths well. The clay that had been of the usual character when the borings were made had all become compact and hard, and contained very little water."

William Sooy Smith stated clearly the mechanics of the "theory of consolidation" in 1898 before the Western Society of Engineers. "Initial settlement," "consolidation," and "secondary effect" are all included in his discussion, with no complex technical terminology. He said:

"The simple fact is that there is a gradual settlement that goes on during long periods under loads less than those which the soil will sustain temporarily. This probably results from the gradual squeezing out of the water in the clay through its infinitesimal interstices by the superincumbent loads. As the time during which this movement of the water takes place increases, the velocity and resistance from friction diminish, and as the water disappears the clay is more easily compressed, and hence this slow settlement."

An "equation of consolidation" was given by Henry H. Carter, M. Am. Soc. C.E., in 1892 in the *Journal of the Association of Engineering Societies*, on the settlement of the embankment between Squantum and Moon Island, Boston main drainage work. Curves were drawn of levels taken over a period of nine years. Carter stated that all the curves of settlement were rectangular hyperbolas in which time, settlement, and two constants were included. Carter also estimated the maximum settle-

ment that would occur, and the year in which the embankment would cease to settle at a rate greater than 0.01 ft per year.

The danger and error that may result from extrapolation of tests made on a single pile were clearly pointed out by G. Weitzel, by Beauregard, by W. Elliot, and by Roy in a circular of the Office of Chief of Engineers reprinted in 1882 in Van Nostrand's *Eclectic Engineering Magazine*. Furthermore, it was discussed by J. Foster Crowell in 1892 and by Charles Sooysmith in 1896 in the TRANSACTIONS of the American Society of Civil Engineers. The conclusions of Horace J. Howe, Jun. Am. Soc. C.E., in 1898 in the *Journal of the Association of Engineering Societies*, may be said to represent the statements of the engineers mentioned. Howe concluded: "(a) That a single test pile, when driven separately and apart, and loaded with an ultimate load, is inadequate. (b) That a single test pile in a cluster, loaded with an ultimate load, is inadequate. (c) That a test is accurate only when it fulfills all of the subsequent conditions of loading, and is made over a sufficient area and for a sufficient period of time."

The possibility of overloading a soft stratum, and perhaps driving piles too closely, was discussed by Weitzel, by Beauregard, and by Roy in 1882, by Collingwood in 1891, by Charles Sooysmith in 1896, and by others. The statement by Charles Sooysmith before the American Society of Civil Engineers is noteworthy in its clearness and simple use of statics:

"If the stratum below the piles be at all yielding . . . the bearing capacity of the foundation is the bearing capacity of the stratum below the piles plus the friction of . . . the outer side surfaces of the entire mass penetrated by the piles. In other words, the piles merely replace so much yielding material and transfer the load to the stratum beneath them."

On this same question, "conoids of pressure"—now called "bulbs of pressure"—were discussed in a circular of the Office of the Chief of Engineers reprinted in 1882.

Long before 1914 the distinction between the resistance of a soil to driving and that to a permanent load was clearly discussed. Other matters considered were "point resistance" and "resistance of friction." Remolding of clay was also discussed, but the explanation advanced was that the clay close to the pile was disturbed during driving, became wetter, more slippery, and then more compact after a lapse of time. That a pile may sink steadily under a permanent load, although it withstands perfectly a blow of the driver, was discussed by Rudolph Hering, M. Am. Soc. C.E., in 1879 before the Engineers Club of Philadelphia, by Weitzel in 1882, and by Charles Davis Jameson, M. Am. Soc. C.E., in 1889 in the *Railroad and Engineering Journal*. Weitzel stated that "most materials require a less force to change their form slowly than rapidly," and that a substance like clay "might resist driving piles very strongly and yet furnish a very much smaller resistance to a permanent load."

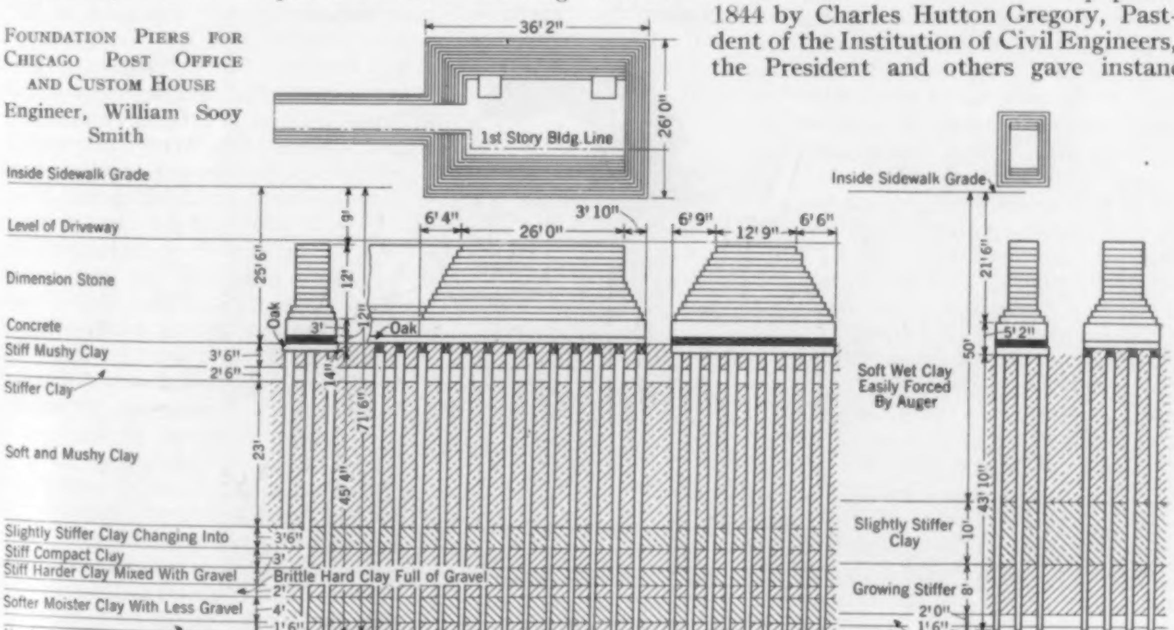
Before 1914 the technical literature included more than mere discussions of "classical earth pressure theories." Structures were studied under actual conditions; also, controlled experiments were conducted in laboratories.

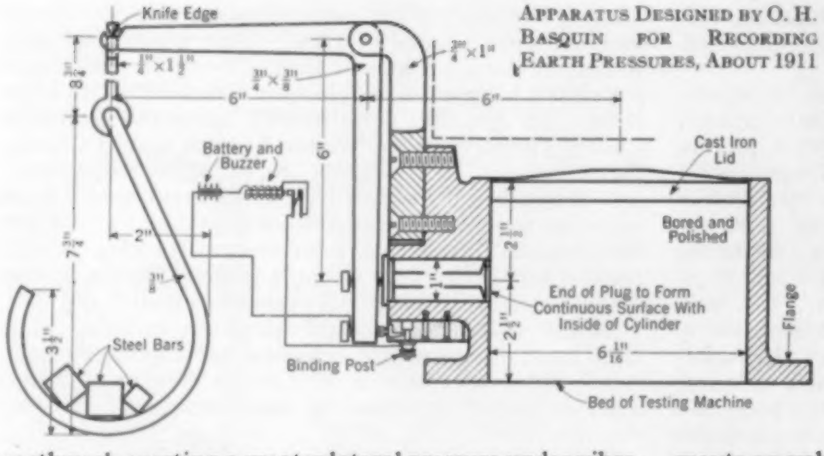
The "true" lateral pressure of earth against a retaining wall is not the problem of the engineer who designs it. The designer may be interested in the possible, but is particularly interested in the probable, values of the lateral pressure. American engineers did not believe that the distribution of lateral pressure was always hydrostatic. The assumption that it might be hydrostatic was one of convenience rather than of certainty. The classical earth pressure theories also served the purpose of making some computations, either for office record or for giving some scale to problems.

Studies of possible lateral pressures of earthwork or granular materials were reported by Benjamin Baker, Hon. M. Am. Soc. C.E., in 1881, G. H. Darwin in 1882, L. Leygue in 1885, W. W. Curtis, M. Am. Soc. C.E., in 1886, A. A. Steele in 1899, J. A. Jamieson in 1903, E. P. Goodrich, M. Am. Soc. C.E., in 1904, J. C. Meem, M. Am. Soc. C.E., in 1908 and 1910, and others. Although the papers of Baker, Leygue, and Darwin were of foreign origin, American writers often referred to them.

Baker's work is remarkable for the many studies of retaining walls, tunnels, trenches, and dock walls in actual service and not under controlled tests. Baker concluded that computed pressures were twice too large and that coarser materials exert smaller pressures. Baker stated that the assumption that the pressure of earthwork is similar to that of a fluid is one of convenience rather than of truth. He referred to a paper read in 1844 by Charles Hutton Gregory, Past-President of the Institution of Civil Engineers, when the President and others gave instances of

FOUNDATION PIERS FOR CHICAGO POST OFFICE AND CUSTOM HOUSE
Engineer, William Sooy Smith





APPARATUS DESIGNED BY O. H. BASQUIN FOR RECORDING EARTH PRESSURES, ABOUT 1911

earthwork exerting a greater lateral pressure under vibration than when at rest.

The experiments of L. Leygue, though small in scale, resulted in qualitative conclusions. He studied the "prism of maximum thrust" by placing colored layers in masses of sand supported by small model retaining walls. He stated that the surface of rupture is not plane but approximately cycloidal, that the prism (and consequently the thrust) is markedly affected by the angle of internal friction, and that this angle increases with the consolidation of the mass. Furthermore, he stated that the center of pressure varies with the nature of the material and the slopes of the wall and surcharge.

W. W. Curtis, M. Am. Soc. C.E., in 1886 in the *Engineering News*, presented data reported by several French investigators on physical and mechanical properties of sand. Curtis described experiments made by Moreau in 1832 and by Niel in 1836 on the pressure of sand on yielding trap-doors. Curtis discussed clearly the "arching" property of sand and stated: "Sand, . . . if a . . . wall yields, . . . buttresses itself against the more resisting parts; beyond a certain limit cohesion and friction are unable to retain it." J. C. Meem also reported in 1908 to the American Society of Civil Engineers experiments on yielding trap-doors. The "arching" property of sand was also discussed by Meem in 1908 and 1910, and by E. P. Goodrich in 1910 before the American Society of Civil Engineers.

American engineers pointed out before 1914 that the lateral pressure on retaining walls or timbered sides of cuts may be small at the top and large at the bottom, or large at the top and small at the bottom, or small at the top and bottom and larger somewhere in between—or it may be zero. Meem stated in 1908 in the TRANSACTIONS of the Society that lateral pressure varied "in direct proportion to the care with which the sheeting was originally placed." S. M. Swaab, M. Am. Soc. C.E., stated the same in 1908 before the Engineer's Club of Philadelphia, in describing the construction of the East Market Street Subway in that city. Considerations other than theories of earth pressure required larger timbers at the top of the trench during construction. Swaab stated: "The best systems of timbering are provided to prevent a slip of the banks, rather than to hold up the banks after they have slipped, in which case only can the pressures approximate the theoretical pressures."

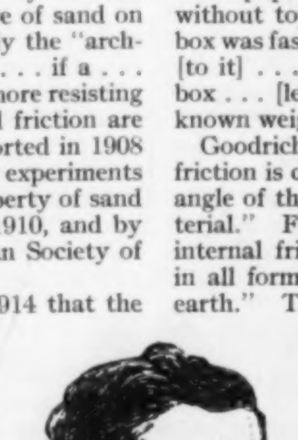
The importance of good drainage behind a retaining wall was recognized long before 1914. This may be verified by inspection of the records of various railroad companies. In many cases drainage was provided for by graded filters. In an editorial of the *Engineering News* in 1905 the following comment was made on a paper by H. P. Boardman, M. Am. Soc. C.E.: "Good drainage can add more years to the life of a retaining wall and save more cubic yards of masonry in its construction than any other thing in connection with it. In fact it may not be far wrong to say that there is more need of good engineering in placing the filling behind the wall than in building the wall itself."

Several investigators conducted experiments on values of the angles of internal friction of soils (as distinguished from the angles of repose). Several conclusions made by G. H. Darwin in 1882 are noteworthy. He stated, "the coefficient of maximum internal friction is probably very different in different parts of a mass of sand," is probably nowhere equal to the angle of repose, and "is a function of the pressure," and also, "of the pressure and shaking to which at some previous period the mass of sand has been subjected."

Goodrich reported the results of his experiments on soils in 1904 before a meeting of the American Society of Civil Engineers. The series of tests included triaxial compression tests and direct shear tests of various earths. The apparatus used for these direct shear tests was identical in principle to that used in modern laboratories. A description and illustration of the apparatus was given in his paper. The apparatus consisted of "two boxes . . . without tops and only one with a bottom. The latter box was fastened [to a base and] . . . had a pulley attached [to it] . . . . a line [attached to] . . . the other [upper] box . . . [led] over the pulley to a scale pan upon which known weights can be placed."

Goodrich stated that the "limiting angle of internal friction is certain to differ in most cases from that of the angle of the natural slope of the free surface of the material." Furthermore, he emphasized that "angles of internal friction and not of surface slope must be used in all formulas which involve the sliding of earth over earth." These statements were repeated often by him and were referred to by other writers. O. H. Basquin of Northwestern University made similar investigations on angles of internal friction. Triaxial compression tests, and studies of lateral pressures and of angles of internal friction were made in connection with the soils of the Pleasant Street Subway in Boston and the Detroit River Tunnel. These were reported in 1907 and 1908 in theses submitted by students to the Massachusetts Institute of Technology.

The properties of earth were studied before 1914 as a part of the American tradition of foundation engineering. Furthermore, foundation engineering was correctly recognized as an art; science played its part only as an aid to extend judgment. This does not say that "science" is not worth doing. Valuable work is being done now, but it should be a correlation and continuation of the previous work of American engineers. It should not forget the work, ideas, and experiences of these pioneers.



WILLIAM SOOY SMITH, M. AM. SOC. C.E.
In 1898 Stated Clearly the Theory of Consolidation, Initial Settlement, and Secondary Effect

Design and Control Testing for the Embankment of Denison Dam

By Frank M. Van Auken

Chief of Soils Laboratory, U.S. Engineer Office, Denison, Tex.

Denison Dam, with its 18 million yards of rolled fill, will have the greatest volume ever incorporated into such a structure. After briefly describing its construction, Mr. Van Auken explains the method of sampling and testing the compacted pervious and impervious fills. Of special interest are the procedures developed for obtaining all the test results on the soils within two hours after sampling. One such innovation is a hydraulically operated sampler, truck mounted. This paper was originally delivered before the Texas Conference on Soil Mechanics and Foundation Engineering, which was held at the University of Texas in February of this year.

Near Denison, in northern Texas on the Red River, the largest rolled-fill earth dam in the world is under construction. It is being built to control floods and to provide storage for the development of hydroelectric power. The total reservoir capacity is nearly 6,000,000 acre-ft.

In cross section the rolled-fill embankment is divided into three sections, consisting respectively of impervious, pervious, and random pervious zones. The top of the embankment will be at El. 670 above sea level with the lowest point in the foundation at El. 480, making the maximum height 190 ft. The entire length of the embankment will be about 17,500 ft, of which 2,000 will be occupied by the spillway. About three miles north of the main embankment, a dike 5,800 ft long will protect a low saddle. The dam will contain nearly 18,000,000 cu yd of rolled fill consisting of 8,500,000 of impervious, 4,000,000 of pervious, and 5,500,000 of random pervious material.

Choice of Technique

Selection of embankment materials has usually been based on the principles outlined by C. H. Lee or by R. R. Proctor, Members Am. Soc. C.E. The method of the former involves the use of particle-size correlation with the results of physical tests, while that of the latter is based entirely on moisture-density relations. Both methods have their shortcomings, but if the moisture-density relations are properly applied and systematically refined they do present an ideal method of setting up the range of field conditions ordinarily met in rolled-earth dam construction.

Accordingly, the physical characteristics of each borrow area were determined from a series of expansion-consolidation and shear tests, which were performed on test specimens compacted to various densities at different water contents. In the application of shear test data, cognizance was taken of the fact that the so-called constants, ϕ (apparent angle of internal friction), and c (cohesion) are not constants. Since most means of computing the stability of an earth structure necessitate the assumption that the shear test values are constants, it was necessary to perform the tests under a number of different conditions in order to evaluate constants that could be used safely. The problem was a difficult one because it was realized that little is known of the stress relations between the small test specimens and the prototype. The true angle of internal friction of both impervious and pervious soils could be determined and applied directly in mathematical formulas of compatibility.

However in determining this true angle of internal friction of clays, even with the slow triaxial compression test, it is never known whether or not the time of test has been extended long enough. Since several months are consumed in tests of this type, it was apparent that some other means of setting up design test data would have to be used, especially since time was a factor. With this in mind recourse was had to the quick triaxial compression test with drainage prohibited. Then, when tests of this type are performed on embankment or foundation materials, an apparent unit strength is determined which has included the loss of strength due to the fact that pore water pressures are partially active.

It was considered extremely difficult to saturate a clay specimen absolutely—it is even doubtful whether or not a pervious specimen can be completely saturated without entrapping some air in the pore fluid. Therefore no attempts were made to saturate clays, but the

General View, Denison Dam
Placing, Spreading, Scarifying, and Rolling Impervious Fill

WORK ON PERVIOUS FILL—PLACING AND SPREADING

strength of these materials at saturation was predicted from the trend of tests performed on materials approaching saturation.

For design, test values that were representative of the strength of the soils at saturation were used in making computations for stability by the ϕ circle, the theory of elasticity, and the method of Rendulic. The results of slow triaxial compression tests were used in computing the ultimate strengths of the embankment materials at final and adjusted stress conditions. The critical void ratio theory was not considered suitable for establishing design criteria on pervious materials because pore-water pressure tests showed that generation of a stress condition at which failure would ensue would cause rupture of the materials regardless of the densities to which these soils could be compacted.

CONSTRUCTION METHODS AND PROGRESS

As of May 15, 1941, the contractor had placed about 4,000,000 cu yd of fill out of a total of 18,000,000. From 22,000 to 53,000 cu yd were being handled daily, with 4 shovels and 43 hauling units. Ten-wheel trucks and six-wheel tractor-trailer units with a capacity of about 20 cu yd each haul both pervious and impervious materials. Two $6^1/_2$-yd electric, and two 3-yd diesel, shovels are used for borrow-pit excavation, while one $1^1/_2$-yd gasoline shovel and one 2-yd steam shovel handle odd jobs about the dam.

Both the pervious and impervious borrow pits are stratified with variable soils. In order to get a uniform mixture, all excavation is made from a face cut the full depth of the borrow, which varies from 15 to 18 ft. The material is spread in 6-in. loose layers and is worked by scarifying until the proper moisture content has been obtained. Then the rolling is accomplished by 7 passes of an extra heavy roller, exerting a foot pressure of over 550 lb per sq in. The rolling unit consists of two double articulated sheepsfoot rollers connected in parallel and drawn by a 100-hp tractor. The total weight of the unit is over 60,000 lb.

The pervious section is constructed in 12-in. loose layers which are wetted to about 90% saturation before and during rolling. The rolling consists of 6 passes of a single, double-articulated roller. This results in more coverage by the tractor treads, which produces greater compaction on account of the vibration of the tractor. Water for the pervious section is obtained from several storage tanks supplied from large wells, and is distributed on the fill by 4-in. hoses and three large tank trucks, each with a capacity of nearly 4,000 gal. Prewetting by ponding is also accomplished successfully.

Almost all the impervious embankment materials have been sampled by hand; but, because of the methods of control adopted for the Denison Dam and the quantity of material placed by the contractor, a method had to be devised whereby such samples could be obtained quickly and with minimum disturbance. A satisfactory solution was found in using a thin-walled steel tubing of various diameters.

The method of obtaining the samples involves the use of a truck-mounted drill rig equipped with a special header connected to a hydraulic feed. A sampling tube of the desired size is attached to the header and, in order to create as little disturbance to the material as possible, it is rapidly forced into the compacted fill by continuous hydraulic pressure. After considerable experimentation it was found that minimum disturbance resulted when the total time of a 6-in. penetration was 1 second or less.

All samples obtained by this method are taken at least 1 ft below the surface of the fill in order to secure the full effect of the compaction energy expended on each successive layer. The soil above the sampling elevation is removed with an ordinary earth auger so that a pene-

SAMPLES OF IMPERVIOUS MATERIAL OBTAINED QUICKLY AND WITH MINIMUM DISTURBANCE

Hydraulic-Pressure Assembly on Truck-Mounted Drill Rig

tration of not more than 6 in. by hydraulic pressure is necessary. The sample contained in the tubing is then sent to the laboratory for testing. In order to eliminate the necessity of additional laboratory preparation of test specimens, all samples required for density, triaxial compression, and consolidation tests are taken with tubing of the exact size required by each testing unit.

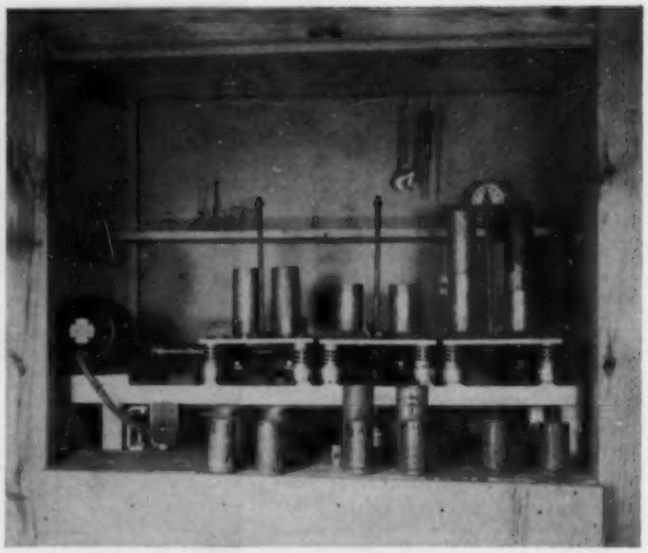
Since no field testing is actually performed on the embankment, all samples are sent to the laboratory. Increased accuracy of control results from this procedure since maintenance and calibration of equipment can be handled with more care. Considerable thought was given to a means of ejecting the samples from the tubing. A mechanical jack and compressed air were tried but neither was entirely satisfactory. Through experimentation, a double-action hydraulic jack arrangement was devised, applying oil pressure to a piston which neatly fits the tubing. The sample is removed in a horizontal position, while carefully supported in a split cylindrical tube slightly larger than the sample.

Attempts to sample the pervious materials by the mechanical method were unsuccessful and resort was had to the usual hand-carved samples, taken in brass cylinders 1/30 cu ft in volume. The samples are screeded flush at each end and steel plates are clamped over the faced surfaces. The entire sample is then sent to the laboratory for void ratio determination.

SOIL TESTING

Control methods at the Denison Dam, although basically similar to those used on other structures of the same magnitude, show a marked departure in detail from those following the principles first outlined by Proctor in 1933. Field control is obtained entirely by routine and detailed testing of samples taken from the fill during and after rolling. Studies of the impervious materials indicated that those soils had a marked tendency to expand when permitted to absorb water. Expansion pressures of from 0.5 to 2.5 tons per sq ft were developed in materials compacted to dry densities of from 105 to 125 lb per cu ft at their respective optimum moistures.

While, with respect to shearing resistance, it would seem practical to compact to high densities those soils that normally indicate the highest initial shearing strength, it is apparent that the normal loss in shearing strength due to saturation would be augmented by the intrinsic pressures created by the release of the capillary forces. Thus we not only have a lower compaction limit, but also an upper limit beyond which high densities may prove detrimental. For control purposes the limiting dry densities were set at 109.5 to 115 lb per cu ft



Vibration Device to Determine Minimum Void Ratios to Which Pervious Materials Can Be Compacted

at optimum moistures of from 17 to 15% respectively. Since both density and moisture content are used as control yardsticks, there is little possibility of any impervious material being compacted to too high a density.

Moisture control on the impervious section of the embankment has been facilitated, since the natural moisture content at the borrow pit is slightly in excess of the selected optimums. Actual control is maintained by close inspection and by determinations of constant moisture content and density. The average water content and dry density based on 1,500 samples taken to date indicate values of 16% and 112.9 lb per cu ft respectively. Another criterion used for accurate control is the shearing strength in place; results of over 150 triaxial compression tests have shown values well over the required minimum.

Studies of the pervious materials indicated that they were cohesionless and that their angle of internal friction varied from 32 to 40 deg, depending upon the compacted density. The density to which these materials can be compacted is closely related to their grading characteristics. Therefore it is impossible to establish a specific density or range of densities for control placement. Rather, a method is used in which two arbitrary constants, the minimum and maximum void ratios (e_{min} and e_{max}), are evaluated in order to compensate for variations in grading. This test method results in a value called "relative density." Based on the results of triaxial compression tests, a value of 80% was set up for control purposes.

Hydraulic-Pressure Apparatus Used to Eject Samples from Tubing

Moisture control on the pervious materials is not as sensitive as on the impervious section. The materials are placed and rolled as close to complete saturation as is compatible with good working conditions. Actual control is maintained by close inspection and occasional undisturbed void-ratio samples, from which the relative density is determined. Based on the results of 500 samples, an average relative density of 95% has been obtained.

The type of control being used on the embankment at Denison Dam demands that all test results be expedited; there-

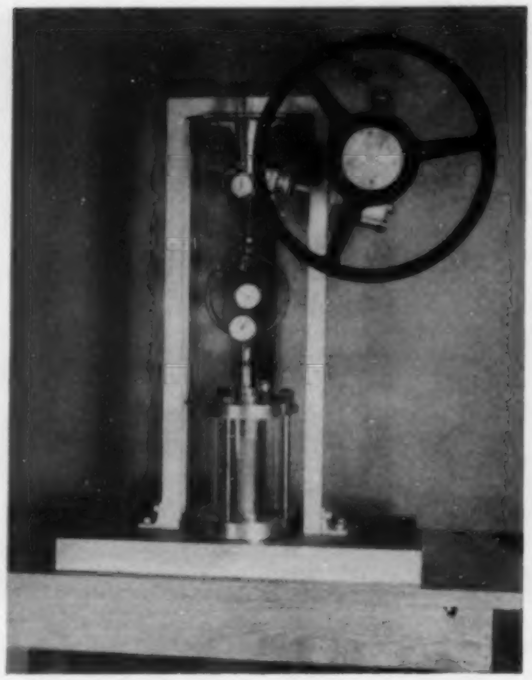
fore rapid-fire procedures are used. Moisture contents, unit weights, and void ratios must be determined within a two-hour period. In order to fulfill these requirements, short cuts in all test procedure were devised.

Moisture contents are handled in the ordinary manner, except that high oven temperatures are used, it having previously been determined that the ignition loss of the impervious soils was extremely low. Generally about two hours are required for an accurate water-content determination, but if necessity demands, the sample is burned repeatedly in alcohol and the moisture content determined in less than 30 minutes.

Mechanical analysis. The use of particle size as a criterion in the correlation of physical characteristics of soils has declined considerably during the past few years. However, it is axiomatic that some means of classifying soils must be used. Perhaps the Atterberg limits would be of more value than mechanical analysis, but where production is mandatory these tests cannot be considered because of the length of time required. In spite of its apparent shortcomings, the mechanical analysis is still a rapid and fairly accurate method of identifying soils, once their general physical characteristics are known. From the relation of hydrometer reading, time and particle size, an average curve for each material type was chosen; from this in turn the mean particle size was related to predetermined time readings. The Bouyoucos hydrometer is employed. By using exactly 100 grams of soil and a total suspension of 1,000 cc, the actual hydrometer reading, corrected for temperature variations and specific gravity, corresponds to the "per cent finer" at any given time. Thus no computations are necessary, and the moment the test is completed the results are ready for use.

Density tests. Testing of the compaction secured on the impervious section of the embankment is based entirely on the weights and volumes of samples taken by the mechanical method. After the sample is removed from the container, a split-ring collar of the proper size, exactly 4 in. long, is placed around the sample and clamped in place, and the protruding ends are screeded flush. The sample is weighed, then oven dried and reweighed. From these data and the known volume, the unit weights are computed.

Strength tests. Shearing strengths of the impervious materials at the density secured by the specified compaction are obtained from triaxial compression tests. Samples are obtained by the mechanical sampling method in thin-walled tubing of the exact diameter ($2^{25}/_{32}$ in.) required for the test specimen. Usually four or five samples are taken at the same depth in adjacent locations. These samples are then prepared as previously, only in a form exactly 7 in. long. They are tested to failure in triaxial compression at all-around liquid pressures of zero, 2.0, 4.0, and 7.0 tons per sq ft. A constant-strain triaxial compression machine is used, and the results are shown graphically by means of Mohr's circles of stress. From these the rupture curve is drawn. Generally not more than two hours are consumed in these operations; thus a quick comparison can be made of the actual versus the required strengths. The samples are then oven dried and from the original measurements and data recorded during the test, the unit weights, moisture contents, and void ratios are computed.



SMALL CONSTANT-STRAIN TRIAXIAL COMPRESSION TESTING DEVICE

To Check Shearing Strength of Materials After Rolling

The essential laboratory tests in controlling the pervious-fill materials consist of mechanical analyses (by sieving), relative density, and triaxial compression tests. The relative density (P_v) values are determined by evaluating the constants in the following equation:

$$P_v = \frac{e_{max} - e_{nat}}{e_{max} - e_{min}} \times 100$$

where e_{max} = void ratio in loosest state; e_{min} = void ratio in densest state; and e_{nat} = void ratio in situ.

The void ratio, in situ, is determined using a volumetric sampler with which the volume of the sample is determined at the fill. The dry weight and specific gravity are found in the laboratory and from these data the void ratio is determined. The sample is then broken down, screened through a No. 40 screen, and used to determine the maximum and minimum void ratios in the following way. The maximum void ratios are determined by carefully filling a cylinder of known volume with the oven-dried sample. This procedure is standardized so that all tests are performed under similar conditions. The dry weight and specific gravity are determined and the void ratio for this state computed.

Minimum void ratios are determined by means of a vibration machine. The device consists essentially of a spring and cam arrangement subjecting the bottom of the cylinder containing the oven-dry sample to 172 sharp blows per minute. Each pervious sample is tested in duplicate, at the same time, in cylinders of identical dimensions. It has been found that 20 minutes of vibration gives practically minimum void ratios for all pervious embankment materials. From the data obtained from these tests the relative density is then computed.

RESULTS JUSTIFY PROCEDURE

Studies of the results and methods of control set up before construction was initiated have been more than justified by the actual results obtained to date. However, the control methods described here require the use of a large and completely equipped soils testing laboratory. It is quite unlikely that an ordinary "field control" laboratory could handle the routine and detailed tests required for the construction control of an earth embankment of this magnitude.

Denison Dam was planned and is being constructed under the supervision of the Corps of Engineers, U.S. Army, with Maj. Gordon E. Textor as District Engineer, John B. Alexander, M. Am. Soc. C.E., as Principal Engineer, and Emlen J. Wanless, as Operations Chief. The Guy F. Atkinson Company has the contract for the construction of the main embankment.

Emulsified Asphalt Used to Stabilize a Highway Base Course

By William S. Foster, Jun. Am. Soc. C.E.

Assistant Engineer in Charge of Street Improvements, Stanley Engineering Company, Muscatine, Iowa

Unusual problems were presented by the use of a "slow-breaking" emulsified asphalt to stabilize the base course of a section of highway in Iowa. Partly because of the weather conditions, some time was required for the base to attain stability, but the road is now giving excellent service. As a result of his experience on this pioneering work, Mr. Foster makes several illuminating observations, among them the recommendation that stabilized base mixes be analyzed on the basis of absolute volume instead of the more usual percentage of compaction, which is subject to various uncertainties.

On the construction of 5.2 miles of highway located on primary Route No. 144 north of Grand Junction, Iowa, the specifications called for stabilization of the base by emulsified asphalt, plant mixed and batch mixed. The wearing surface was to be placed by the inverted penetration method, using a heavier emulsified asphalt for the binder. The roadway was flat to gently rolling, with a maximum grade of 3½%.

Emulsified asphalt specifications called for the material to be homogeneous, to show no separation of asphalt after mixing within 30 days after delivery, and to meet other detailed requirements. The emulsion may be described as slow-breaking, with an asphalt content of from 55 to 60%. The mix for the base was designed on a surface area basis. Design called for an asphalt content of 4% of the dry gravel weight. Later the engineer raised this to 4½%, about half the road having been built at the former mix. This change he felt was necessary because of the cooler weather late in the season.

The contractor used a 27-E concrete paver for mixing, with a 30-sec mixing cycle and a batch weight based on a dry weight of 3,000 lb of aggregate. Aggregate and emulsion were added by weight (4% asphalt, 96% dry aggregate). Water, when necessary, was added by volume. Materials were mixed at the gravel pit and hauled to the grade in dump trucks at the rate of three batches to the load.

Moisture in the aggregate averaged 8½% of the dry aggregate weight. This, with the water in the emulsion, produced a moisture content slightly above the "optimum," with the result that this particular mix was sloppy and hard to handle on the road. Efforts were made on the first quarter mile to compact it with a sheepsfoot roller, but the contractor quickly decided that the most satisfactory results were secured with his rubber-tired rollers.

Inasmuch as plant mix for this type of road was new in this state, the contractor experienced numerous delays before operating efficiently. However, after deciding upon a paver for mixing, he had no trouble getting a satisfactory mix with all particles thoroughly coated with bitumen. He attempted using a continuous mixer but this equipment did not adapt itself to batch mixing.

Because of the weather, the nature of the binder, and the moisture in the material, considerable difficulty was experienced in laying the base. Operations began on October 8, 1938, and were concluded on December 10, 1938. Since operations were started late in the season, the evaporation of moisture in the mix normally expected did not occur readily. A stable base could not be attained until this evaporation occurred; and before this had happened, the emulsion had "broken." This meant that the water had left the emulsion, with the result that the loose gravel particles were coated with hard asphalt, and that free moisture was incorporated from the emulsion to the mix. As a result, the roadway, instead of being bound by the asphalt, contained a mass of well-moistened, relatively coarse-grained particles individually coated with hard asphalt. Since the 200-mesh requirement for the mix was quite low, stability was very hard to attain.

Of interest was the fact that at least two miles of the base were laid in two layers in accordance with the instructions of the engineer. Although it was so late in the season that a fair estimate of this method could not be attained, nevertheless it appeared that the rolling was progressing much more satisfactorily under this method. Field examination of the completed base showed no separation or cleavage between layers. Field tests further showed that these sections had an appreciably lower moisture content than sections laid in one layer.

With the equipment being used, the best figures available showed that 5 roller hours per station were necessary to produce compaction when the material was placed in one layer, but only 1½ roller hours per station when placed in two layers.

Since the base was completed so late in the season, it was not practical to apply the contract wearing surface at this time. To protect the base, the Iowa Highway Commission ordered the contractor to seal the surface with a light, cut-back asphalt classified at that time as MC–1A. This seal was applied at the rate of 0.2 gal per sq yd and covered with sand at the rate of 25 lb per sq yd. This wearing surface proved sufficiently strong to carry the traffic through the winter while the road was in a relatively unstable condition.

The wearing surface, called for by contract, was applied the following spring in three courses, the binder being placed at the rate of 0.3 gal per sq yd for each course and the cover aggregate first at 20 lb per sq yd per course, but later reduced to 15 lb because of the inability of the binder to absorb more. A heavier emulsified asphalt was specified for the wearing surface binder.

Tests for Moisture Content and Density

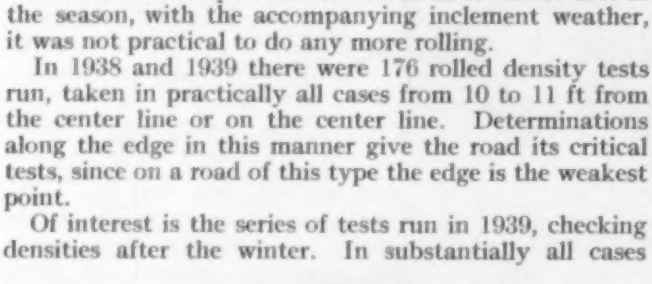
A number of carefully conducted tests placed the optimum moisture content in the base mix at 11%. This was higher than is normally encountered in a stabilized base mix and can be attributed to the lack of fine material in the aggregate. It was not until the moisture content of the mix dropped to a maximum of 7%, that the roadway began to take shape and show some body. On one particular section, moisture remained at 8½% and although tests showed a density of well above the Proctor minimum, the roadway was so lubricated by the moisture as to remain soft and unstable.

The combination of weather and materials made it difficult to obtain the specified density. From the tests

made in the fall of 1938, while construction of the base was in progress, it appeared that about half the base would not be acceptable. However as it was so late in the season, with the accompanying inclement weather, it was not practical to do any more rolling.

In 1938 and 1939 there were 176 rolled density tests run, taken in practically all cases from 10 to 11 ft from the center line or on the center line. Determinations along the edge in this manner give the road its critical tests, since on a road of this type the edge is the weakest point.

Of interest is the series of tests run in 1939, checking densities after the winter. In substantially all cases



GRAVEL FOR THE WEARING SURFACE WAS APPLIED WITH A ROTARY SPREADER

the questionable sections of the base increased in density to above the specified requirements. Although the sections of low test value increased, sections from which the tests were acceptable did not show a corresponding rise.

Of these, figures representing observations previously noted are as follows, in Proctor percentages:

	Weighted Averages	
	1938	1940
Density of sections not acceptable in 1938	97.6	100.9
Density of sections acceptable in 1938	101.2	101.0

The increase in density may be attributed in part to the decrease in moisture content of the base, but to a larger extent to the gradual knitting together of the gravel particles by the asphalt, compacted by the vehicular traffic on the roadway. This was particularly noticeable when the spring weather warmed the base enough to soften the asphalt.

In regard to traffic, the volume carried on this road would be classified as light—no more than 500 vehicles a day. However, for a period of about two weeks late in the summer of 1939, the road was subjected to a volume of from 1,000 to 1,500 trucks a day carrying loads of 5 tons. These trucks were carrying material to another stabilized base job and were of course returning empty. The writer observed no damage to the road during this period. Maintenance crews have pointed out some raveling in the wearing surface since then, but the base, built on excellent subgrade, is giving highly satisfactory service.

CONCLUSIONS DRAWN FROM THE WORK

The writer offers the following as his conclusions from observations of this project:

1. Recognizing, of course, that the effort was to replace the soil binder ordinarily used on a soil stabilization project with an asphalt, one can see why the mix was so extremely low in fines. However, it would appear that a more workable mix would have resulted had the percentage of fines been higher.

2. The writer has observed that a stabilized base mix as generally designed does not assume stability until the moisture content drops to about 60% of the Proctor optimum. It is also noted that an emulsified asphalt, when incorporated into the mix, will "break" within a certain period, in line with the nature of the emulsion. The mix therefore must be compacted and manipulation stopped before the "breaking" action is complete. When the emulsion "breaks," the asphalt begins to bind the aggregate. Further manipulation at that time only breaks the bond that is beginning to form. Accordingly, the moisture in the mix must be such that when the "breaking" takes place, it will be down to the 60% of optimum previously referred to so that the binder will be able to hold the aggregate and develop a stable roadway.

3. On this particular project it appeared that the load produced by the sheepsfoot rollers was so great that it tended to break the binding action of the asphalt. A roller pressure of no more than 125 to 150 lb per lin in. of roller surface appeared to be ample. This was delivered through the medium of rubber-tired rollers with a gross load of approximately 7 tons and an average roller surface width of about 8 ft.

4. As mentioned previously, specifications called for a density in the base equal to that obtained by the Proctor test. This test does not represent the ultimate in density, but rather a consistent and convenient level which engineers of the Iowa Highway Commission feel is necessary to produce a stable roadway. Simple observation of the facts will indicate that with a different sized weight or drop of the tamper, an entirely different set of results will be obtained. However, the test in its present form presents a fairly workmanlike basis on which to judge densities. The writer offers, therefore, his opinion that the relation between the Proctor density and a satisfactory road base is essentially a coincidence. Engineers have discovered that this relation exists and works; and, accordingly, they wish to retain it until something better comes along.

It would appear that consideration should be given to the analysis of stabilized base mixes from the viewpoint of absolute volume. As the absolute volume represents the ultimate that can be expected, it gives a foundation for analysis that means somewhat more than the Proctor test. Differences between the absolute volume density and the density to be attained in the field may be represented by percentage of voids. With the results now available, mixes might be designed so that specifications would call for a minimum of voids rather than a percentage of Proctor density. This would not materially alter construction procedure, but would give a sound approach to the design of roadway bases.

The writer wishes to acknowledge the assistance of A. A. Baustian, district engineer for the Iowa Highway Commission, in making available the necessary data. He is also indebted to R. A. Moyer, M. Am. Soc. C.E., highway research engineer at Iowa State College, and Bert Myers, chief of the Materials and Tests Department for the Iowa Highway Commission, for helpful and friendly criticism. The Hargrave Construction Company of Cedar Rapids, Iowa, held the contract for the work. W. B. Spangler was resident engineer for the Iowa Highway Commission, and the writer served as grade inspector as well as being in charge of tests in the field.

Constructing a Treatment Plant for Industrial Waste

By John W. Greenleaf, Jr., Assoc. M. Am. Soc. C.E.
Assistant Engineer, Metcalf and Eddy, Boston, Mass.

Sanitary cleansing of the important Illinois River has been under way for some time. One phase of this work is described here—a plant for treating 300,000 gal of concentrated waste from a yeast and malt factory of Standard Brands, Inc., at Pekin, Ill. Particular interest attaches to the construction methods to obtain gas-tight digestion tanks, particularly under the conditions of diverse foundation materials and unequal settlement of adjacent structures. This paper was originally presented before the Junior Association of the Northeastern Section at its November 1940 meeting.

Recently at Pekin, Ill., a plant has been built to purify the industrial wastes from a factory of Standard Brands, Inc., so that they may be safely discharged directly into the nearby Illinois River. Some of the problems met in the construction of this plant will be of general interest to engineers.

This improvement is a further step in the program of the Illinois Sanitary Water Board in cleaning up the Illinois River, which flows through the heart of the corn belt and through the Illinois coal fields. The gravel beds under the river and in the valley in the vicinity of Pekin and Peoria furnish an abundant supply of good but hard water. This combination of corn, coal, and water provides raw materials for many of the factories along the river.

Pollution of the stream has long been a problem. Municipalities and industries contribute their load, with the Peoria-Pekin area adding the equivalent contamination of 1,100,000 persons. Thus in spite of natural purification processes, there has been, at times, evidence of pollution all the way to the Mississippi River, some 140 miles below Pekin.

In 1934 Metcalf and Eddy were engaged to make a report on the waste problem at the Pekin Manufacturing Branch of Standard Brands, Inc., and subsequently to direct experiments to determine means of treating the wastes and of securing data for the design of a treatment plant. Plans were prepared by them and the construction carried out under their supervision, the writer serving as resident engineer.

Actually the manufacturing plant is situated some distance back from the river and drains into "Dead Lake." This was, until recently, a more or less stagnant body of water in an old river channel at an elevation some 10 or 12 ft above the present river surface, draining through a small outlet to the river. The wastes from Standard Brands, as well as from a distillery, a paper mill, and a starch plant, plus a small amount of surface drainage, made up the entire inflow to the "Lake." Odors, particularly in summer, were extremely obnoxious and undoubtedly gave the lake its name. Recently it has been filled in except for a channel that still carries most of the waste from the industries.

Wastes from the plant result from the manufacture of yeast and malt products and amount to something over 5,000,000 gal a day. These include a large portion of relatively clean condenser water and a small amount of sanitary sewage. The plan of treatment provides for separating and treating the more concentrated wastes and then recombining them with the condenser water for discharge into the channel. These wastes were estimated to amount to between 200,000 and 300,000 gal per day and to have a biochemical oxygen demand of approximately 8,000 ppm. This is about forty times as strong as ordinary domestic sewage and the effect on the river is equivalent to that of the sewage from between 75,000 and 100,000 persons. The treatment of this waste is quite different from that of municipal sewage; here the settleable solids are chiefly diatomaceous earth, an inorganic material that presents no disposal problem, while the organic matter is in solution. On the other hand, a large part of the organic matter in a municipal sewage can be settled out, and frequently no further treatment is required for the remaining liquid.

As built, the treatment plant (Fig. 1) includes two covered settling tanks, each 12 by 50 ft in plan, which receive the wastes directly from the plant and provide a four-hour settling period at the normal rate of flow. The wastes, after settling, leave the tanks over weirs extending across their full width and flow to the wet well of the pump station, from which they are pumped to the digestion tanks. The pumps are driven by variable-speed motors and are automatically controlled

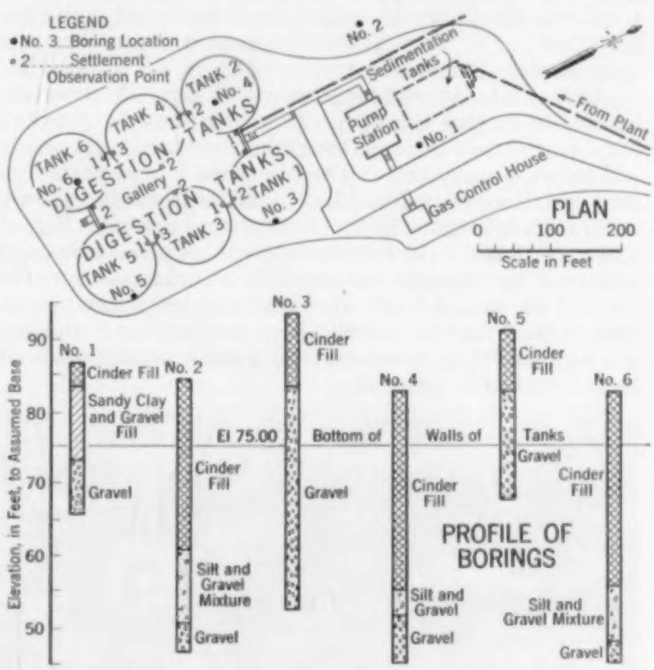


Fig. 1. Plan of Treatment Plant, with Results of Borings

by a multiple-contact float switch to follow the rate of flow. The six digestion tanks, each 50 ft in diameter with a 22-ft side wall and an 8-ft conical bottom, have fixed conical concrete roofs and a total liquid capacity of 2,200,000 gal. They are located three on each side of a roofed-in gallery that contains the controls and all piping except that for gas, which is on the roof.

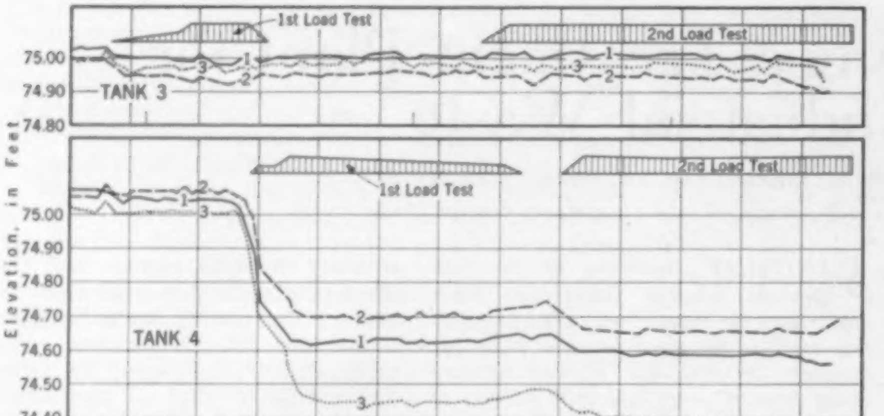
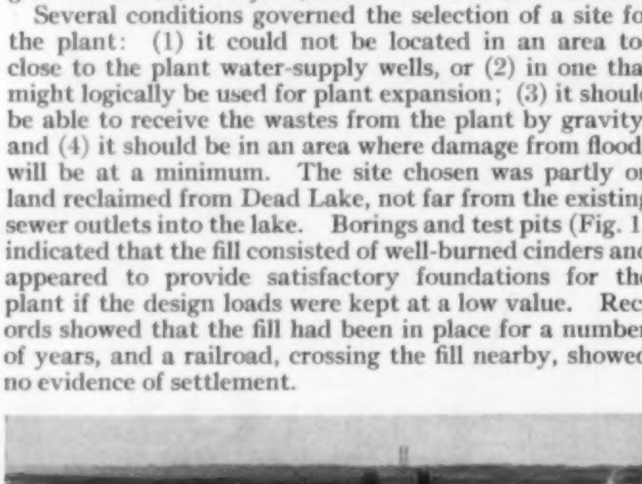


FIG. 2. LOAD-SETTLEMENT TESTS
Numbered Lines Refer to Observation Points in Fig. 1

Each digestion tank is provided with an oil-sealed gas dome that serves also as a vacuum and pressure-relief valve. A gas-meter house at one end of the gallery roof serves as a collecting and metering point for all gas. Meters on each gas line give a continuous record of the gas production of each tank and provide a useful check on tank operation. Gas is piped underground to the control house, where the pressure is regulated and the moisture trapped. For the present the gas is being burned in two waste gas burners located on the roof of the gas-control house, although later it is planned to utilize it either in a gas engine or in the boilers. Calculations based on pilot plant operation show a heat value for the gas of about $2,000 a year, based on coal at $1.50 a ton.

Several conditions governed the selection of a site for the plant: (1) it could not be located in an area too close to the plant water-supply wells, or (2) in one that might logically be used for plant expansion; (3) it should be able to receive the wastes from the plant by gravity; and (4) it should be in an area where damage from floods will be at a minimum. The site chosen was partly on land reclaimed from Dead Lake, not far from the existing sewer outlets into the lake. Borings and test pits (Fig. 1) indicated that the fill consisted of well-burned cinders and appeared to provide satisfactory foundations for the plant if the design loads were kept at a low value. Records showed that the fill had been in place for a number of years, and a railroad, crossing the fill nearby, showed no evidence of settlement.



GENERAL VIEW OF WASTE TREATMENT PLANT FROM NORTHEAST

In construction, one of the first operations was to excavate a pit and conduct a loading test near one of the earlier borings in the fill area where the digestion tanks were to be built. A 30 by 30-in. platform was loaded to give the design pressure, and observations were taken for several days until no further settlement occurred. A total settlement of 2 in. was recorded but since $1^1/_2$ in. of it occurred when the load tipped, it was thought that this was excessive and did not represent what might be expected. However, the tanks founded on cinders were constructed an inch higher than the others.

Excavation showed that the east line of three tanks was almost entirely on gravel while the others were entirely on cinders. The excavation in gravel was completed in the dry and without incident, using a dragline for all but the final part, which was done by hand. Digging for the other tanks soon showed that the area had been used as a dump, and contained large quantities of old roofing and lumber not disclosed by the borings or test pits. In addition, water was found 3 ft above the bottom of the excavations, while tank bottoms in gravel 60 ft away were dry. The water level in the fill was found to be the same as in Dead Lake and pumping showed a good hydraulic connection. A layer of clay several feet thick prevented this water from reaching the true water table, which was some 15 ft lower. The roofing and old lumber were removed to a point well below the water level and the entire space was refilled with gravel. The contractor found it necessary to construct a concrete false bottom under each tank in order to build the tank bottoms in the dry without depending on pumping. Under the other tanks a thin layer of concrete was placed over the gravel to hold it in place and to furnish a support for the heavy reinforcing mat.

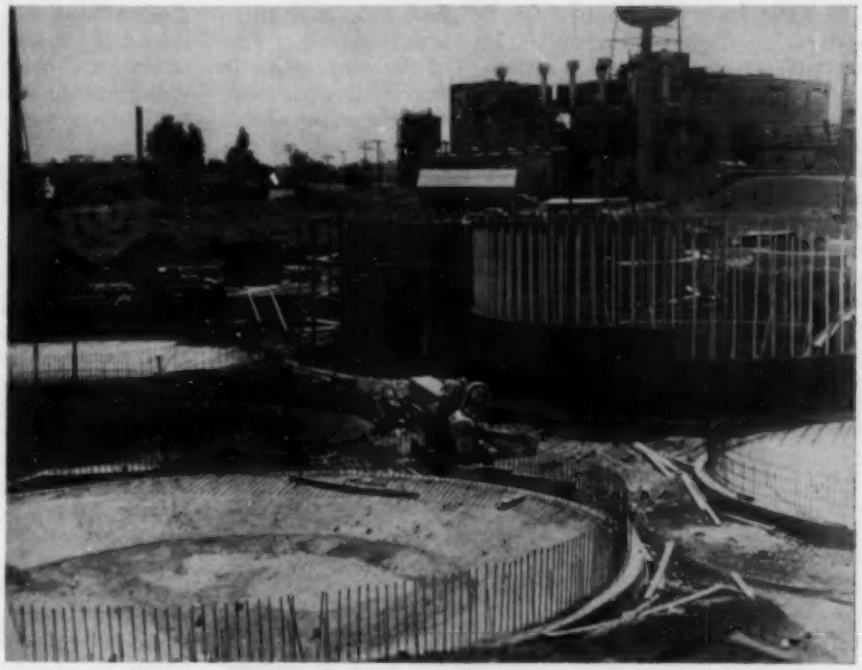
CONCRETE MIXING

Concrete was mixed in a 1-yd paver, which was moved around the job so that it would be near the point of pouring. Gravel aggregate came from a nearby wash plant with a haul of less than a quarter mile. Aggregates were loaded directly into trucks with hinged partitions to separate the two batches. Some trouble was had in controlling the amount of water, since aggregates were taken directly from the gravel plant hoppers and since the water varied with the production of, and demand on, the plant. This difficulty was largely overcome by the use of an extra batching truck and by allowing each truck to stand with its body tipped up to drain off all free water before the batches were dumped into the mixer. This procedure, with some variation in the amount of water added at the mixer, made it possible to control the mix very well.

Concrete proportions were determined by trial mixes at the Pittsburgh Testing Laboratory. Concrete used in footings and heavy mats contained five bags of cement per yard, and that in the walls, slabs, and thinner sections contained six. Regular cement was used except for the digestion tank roofs, where the contractor elected to use high early-strength cement. In all cases, test cylinders taken from each pour showed strengths well above the 2,200 lb required at 28 days.

Form panels were used for the walls of the tanks with some success. These consisted of 2 by 3-ft welded steel

angle frames faced with $^5/_8$-in. plywood and arranged so that a patented steel strap tie and spreader held adjoining panel sections together. The chief difficulty was occasioned by the difference in the diameter and consequently in the length between the inside and outside forms, and the necessity of using the same number of panels on each form. Hence filler pieces were required after every third panel. These made slow work and were difficult to hold in place. Irregularities in the concrete, caused by the movement of filler pieces, were difficult and costly to remove and finish, where the walls were left exposed. The angular joint formed at each vertical panel junction added considerably to the cost of finishing and largely offset any saving in cost through the use of these forms. To meet the specifications that ties be kept back $1^1/_2$ in. from the face of all walls in contact with the waste, a special coil spring and washer arrangement was used to expose the ties the required distance and permit cutting them off with a chisel and hammer. Then it was necessary to fill the holes with a non-shrinking mortar as a seal against the entrance of waste.



CONSTRUCTION OF DIGESTION TANKS, IN VARIOUS STAGES
Looking Northeast Toward Manufacturing Plant

Erecting the forms was a comparatively easy matter. A collar, made up of segments of inch boards, was first set to line and grade and the first row of panels set up and locked together on it. Two-by-four studs were then set up on the collar and tied to the panels with special hooks provided for that purpose, after which the other rows of panels were set up to the full height and tied to the studs. The studs were then braced to cleats bolted to the tank floor for that purpose. The outside forms were erected two rows at a time, giving a 6-ft lift to the pour. Reinforcing was placed after the inside forms were completed and was tied to them.

Runways were built entirely around the outside of the forms, supported from the inside wall form by brackets that hung from it with an outside leg resting on the ground. These brackets were used in scaffolding for placing reinforcing and erecting outside forms.

Long ramps were laid from the mixer to the runways. Rubber-tired wheelbarrows proved very satisfactory and made it possible to use narrower runways than would have been required for buggies. Concrete was placed in the walls directly from the wheelbarrows without chuting. It was vibrated into place with an internal-type vibrator after a discouraging experience with hand puddling.

Forms for the conical concrete roofs on the digestion tanks had to be supported from the floors of the tanks; they were 22 ft and 38 ft high, respectively, at the side and center. The contractor erected, in the center of each tank, an octagonal tower upon which were supported the 2 by 10-in. roof rafters. These extended radially to the wall forms and were decked with $^5/_8$-in. plywood. A 3-ft hole at the center, over which the gas domes were placed, provided the only means of access to the under side of the forms. Each piece of lumber had to be of such size that it could be removed through this hole. On this work the contractor found it advantageous to use two sets of forms and high early-strength cement.

The top 4 ft of wall and the roof of each tank were poured monolithically to eliminate a joint in the gas-collecting part of the tank. A crane with a bottom-dump bucket lifted the concrete to a hopper, from which it was placed with wheelbarrows. The concrete was covered with burlap as soon as it was floated and was kept wet until the forms were stripped. In spite of this precaution, a number of shrinkage cracks occurred—some almost before the concrete had set.

Concrete work on the pump house, settling tanks, and gas control house followed the same general procedure except that forms were of tongue-and-groove sheeting erected and braced in the usual manner.

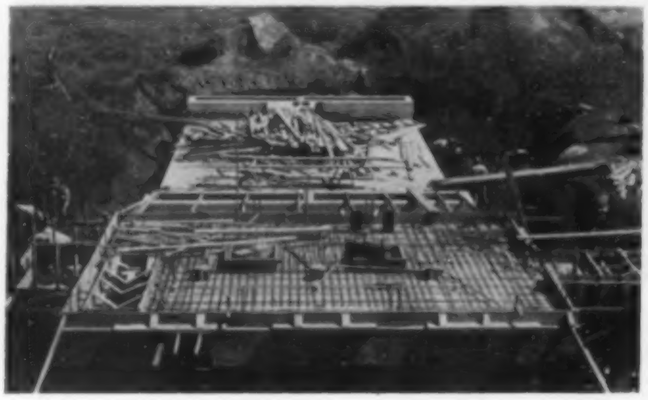
The interior of the conical roofs and the top 4 ft of the side walls of each tank were given a $^1/_2$-in. coat of gunite to seal any cracks and insure gas tightness. The contractor evolved an ingenious scaffold and thereby made a substantial saving in both time and money. It consisted of a platform suspended at the inner end from the gas dome by a post and kingpin, and supported at the outer end by three legs mounted on wheels which rode on the tank bottom. The rig was light, easy to assemble and move, and could easily be operated by one man. Gunite was also used to patch holes in walls where honeycombing had occurred before the vibrator was used.

The specifications required the contractor to keep each of the completed digestion tanks filled with water for a period of seven days. Typical results of this loading test are shown in Fig. 2 for Tanks 3 and 4. The purpose was twofold: to make certain that the concrete was watertight before applying insulation and brickwork, and to determine the actual settlement under full load before building the gallery and installing the piping. Rate of loading is shown by the cross-hatched area above the settlement curves. Loading was stopped when Tank 4 was partly filled so that the adjoining tanks might be loaded and equalization of settlement take place. Observation points (Fig. 1) were on top of the tank bottoms where they extended beyond the walls; they were 90 deg apart and restricted to portions of the tanks adjacent to the gallery, since backfill had been placed elsewhere.

Tanks 1 and 5, founded on gravel, acted in a similar manner to Tank 3 (Fig. 2), settling from 0.05 to 0.08 ft

when the load was applied for the first time and then recovering about 0.03 when the load was removed. The second test on these tanks, although of the same amount and for a much longer period, showed less total settlement than the first. A possible explanation is the effect of the weight of the brick veneer placed on the outside of the tanks between the first and second tests and on the opposite side from the observation points. Although the weight of the veneer amounts to only about 5% of the total, it is concentrated on the outside edge of the tanks and opposite the observation points.

Similarly, Tanks 2 and 6, with cinder foundations, each followed the same pattern of settlement as shown for Tank 4. All three tipped and moved laterally in the same direction. The axis of tipping was approximately 45 deg to the line of the tanks, and the direction of tilt and lateral movement was toward what had been Dead Lake. This should have been expected since the fill under this side of the tanks was considerably deeper than that on the other, as indicated by the borings, Fig. 1. These tanks also showed a marked recovery or rebound when the load was removed, and Tank 2 showed little further settlement when loaded for the second time, as was the case with the tanks founded on gravel. Leakage from Tanks 4 and 6 during the first test caused a reduction in the load on them and thus prevented their reaching full settlement during the test, with the result that substantial further settlement took place during the second test.



PUMP-STATION SUBSTRUCTURE, WITH SETTLING TANK IN BACKGROUND, BEFORE BACKFILLING

Observations on Tanks 2, 4, and 6 showed a maximum settlement of 0.58, 0.70, and 0.54 ft, respectively. This resulted in the tanks being about 2 in. out of plumb and several inches away from their original location.

The second test indicated that the tanks, even though founded on different materials, could be expected to behave in the same manner when loaded and unloaded during plant operation and that no further substantial settlement was likely. This expectation was fulfilled when the tanks were filled at the completion of the work.

It is interesting to compare the action of the tanks on cinders during the loading test with that of the test conducted at the beginning of the job. The tipping and rotating that had disturbed the original load test was noted in the settlement of the tanks and apparently is the manner in which cinders behave under an increasing load. Had this been realized earlier, the tanks would have been set higher so that the final difference in elevation would have been less.

Placing insulation on the tank walls was not difficult, but laying brickwork out of plumb was a new experience for the masons and caused them some trouble. A straightedge was substituted for the usual level and the resulting job was entirely satisfactory. A leveling course of common brick was placed on the concrete ledge provided to support the brick, and the brickwork was carried to the same top elevation by extending the parapet where necessary. The exposed surfaces on the tanks and other structures are of manganese-spotted shale brick in a light buff color, which gives a very pleasing appearance to the entire plant.

Walls and roofs of the tanks were insulated to conserve heat. No heating coils were provided, as dependence for maintaining proper digestion temperatures was placed on the incoming wastes. The heat loss from the tanks was compensated for by the temperature of the waste, which was warmer than necessary. The unsatisfactory experience of the owner in the use of natural cork and other organic insulating materials led to the adoption of spun glass or rock wool for insulation throughout.

The gallery between the tanks was carried on a heavily reinforced concrete mat 18 in. in thickness, which formed the floor. Here the unit loads on the foundation were kept to about half of those for the tanks, so that settlement would be minimized. This was done because there was no chance of reasonably loading the gallery and obtaining settlement before the piping was erected and connected to the tanks. Also, foundation conditions were more difficult, since one side of the gallery was founded on gravel and the other side on the deep cinder fill. A clear space of 2 in. was left between the gallery and the tanks to insure freedom of movement between the structures and to permit flood waters to seep into the gallery and relieve stresses due to water pressure. The ledge formed by the extension of the tank bottom beyond the wall was left below the floor of the gallery to serve as a gutter and to aid in washing and cleaning the gallery.

PIPING PROVED TO BE A PROBLEM

The main piping in the gallery is 8 and 10-in. flanged cast-iron pipe with the exception of a 4-in. cast-iron water main. It is arranged to permit considerable flexibility in operation, and will permit the by-passing of one or more tanks as well as the changing of the order of operation. The inlet and overflow piping was hung from the roof slab on adjustable hangers, and the sludge pipe was supported on adjustable pipe stands from the floor. The piping was erected from a rolling stage, a piece at a time, which made slow work. To provide for free movement between the gallery and the tanks, pipe connections to the tanks were supported by hangers fastened to the tank walls. Connections between the tank and gallery piping were made with couplings that will permit movement of $1^1/_2$ in. either way and still maintain a tight joint without straining the piping. The same scheme was used on the gas piping on the tank and gallery roofs.

All electrical work in areas where gas might accumulate was limited to lighting, and all switches and wiring in these areas were in accordance with the requirements for explosion-proof work. All motors, circuit breakers, and other electrical equipment were installed in the pump house in a well-ventilated room and away from gas-collecting or gas-handling equipment.

A concrete road bordered by hedges was extended to the plant, and concrete walks provide easy access to the various units. Well-graded lawns provide a pleasing setting and add to the general appearance of the plant.

James Stewart Corporation of New York and Chicago were the general contractors, and James Jensen served as their superintendent. Roberts Filter Company of Darby, Pa., was the principal subcontractor, handling all piping and equipment.

The Master Plan for New York City

Effort Made to Reconcile Need for Centralization with Existing Drift Toward Suburban Living

By T. T. McCrosky, M. Am. Soc. C.E.

Executive Director, Chicago Plan Commission, Chicago, Ill.; Formerly Director of Planning, Department of City Planning, New York, N.Y.

A city that ceased to change could well expect to find itself classed among the nation's museum pieces. Quite evidently Metropolitan New York, although proud of its legitimate museums, has no intention of allowing itself to become one. Prospects of economic blight in certain areas can be averted through reconstruction; in other areas they can sometimes be blocked by readjustment of transportation facilities. But the goal is not considered a fixed ultimate scheme so much as a succession of plans, each closer than the other to the social ideal of its own era. Mr. McCrosky's paper, outlining these considerations, was originally presented at the 1941 Annual Meeting of the Society.

THE City Planning Commission of the City of New York is required by the charter to prepare a Master Plan, which shall show such desirable "features, changes, and additions as will provide for the improvement of the city and its future growth and development and afford adequate facilities for the housing, transportation, distribution, comfort, convenience, health, and welfare of its population." The charter, furthermore, makes specific stipulations for such features of the Master Plan as streets and highways; parks, parkways, and roads; transportation facilities; sites for public buildings; water distribution, sewage systems, and routes of other public utilities; and building zone districts. The plan is thus a statutory plan and must ultimately include what the charter says it shall include. It differs from the advisory master plans, which are made by most city planning commissions and their consultants and which can be confined to those features and individual interpretations of need that fit in with the particular problems of a particular city at a particular time.

In New York the Master Plan is given a certain legal status, in that it must be adopted by the Commission after public hearing and can be amended or added to after a public hearing. This is a salutary provision, which assures wide popular interest and participation in the development of the plan. At the same time it does not cause undue rigidity, for the plan does not have to be adopted or endorsed by the local legislative body. It remains a document controlled solely by the City Planning Commission, and serves as a guide for the review of projects referred to the Commission for report.

As the Commission recently pointed out, the steps necessary to bring such a Master Plan into being are obviously difficult and present a challenge not only to the Commission but to other agencies of the municipal government and to the citizens of New York. It has been decided that the Master Plan should not be launched at one time with all its parts complete, but rather should be prepared and adopted progressively. No plan is ever really complete, and to delay all adoptions until substantially the whole plan could be presented might mean keeping people too much in the dark as to the procedure of the Commission. Evidently all parts of the plan are closely interrelated and must be coordinated with each other. This can perfectly well be done on a progressive schedule as the parts not yet ready for adoption are, nevertheless, taking shape in the form of sketch plans and ideas evolving in the minds of the Commission and staff.

In January 1940, the Commission adopted a so-called city-wide Master Plan of Sections Containing Areas for

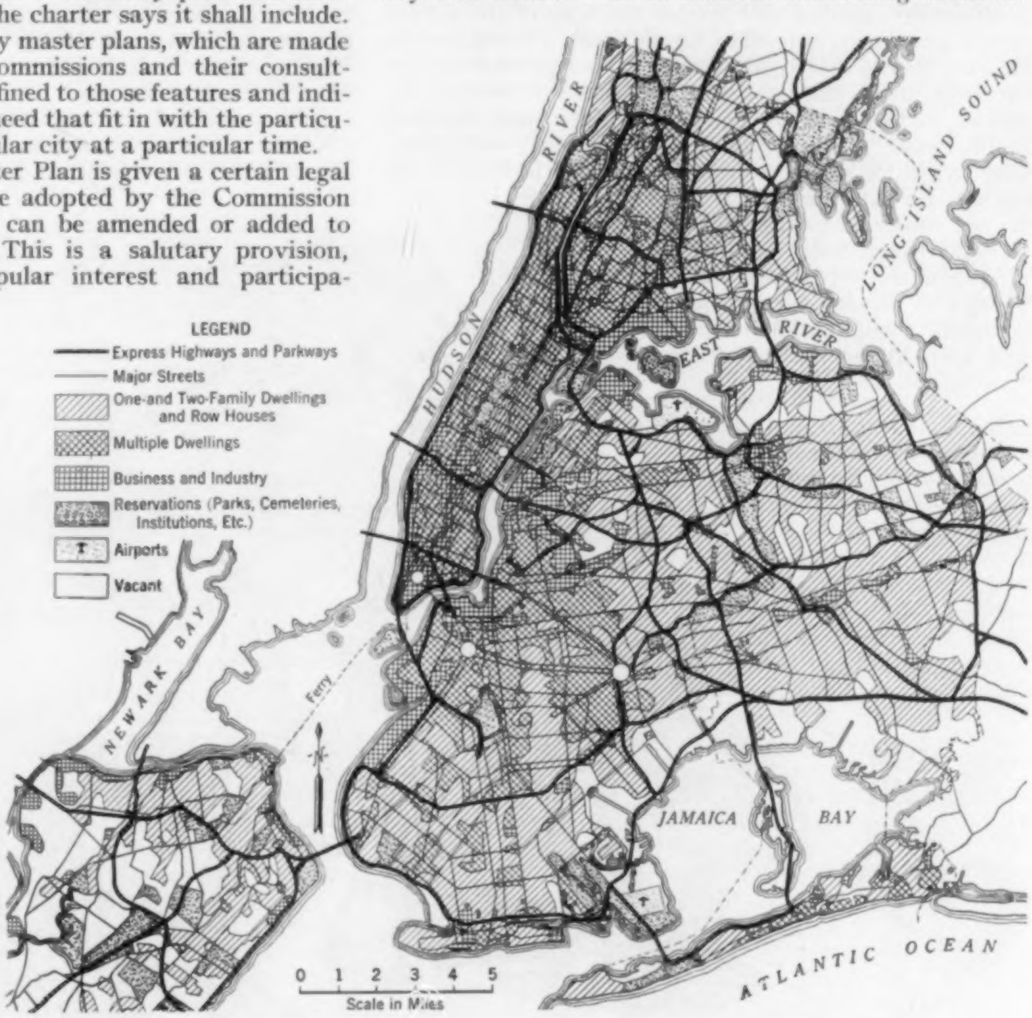


Fig. 1. The Current Plan for Motor Transport Arteries
Existing Land Use Is Shown by Shading

Clearance, Replanning, and Low-Rent Housing. This plan shows all the areas which the Commission believes suitable for public housing projects. These locations lie almost entirely within the built-up slum areas. The ruling criteria for selection of areas were as follows: (1) proper relation to other parts of the Master Plan; (2) permanent residential character; (3) clearance of substandard districts; (4) ability to walk to work; (5) accessibility to rapid transit; and (6) existence of public improvements, including paved streets, water mains, sewers, playgrounds, and schools.

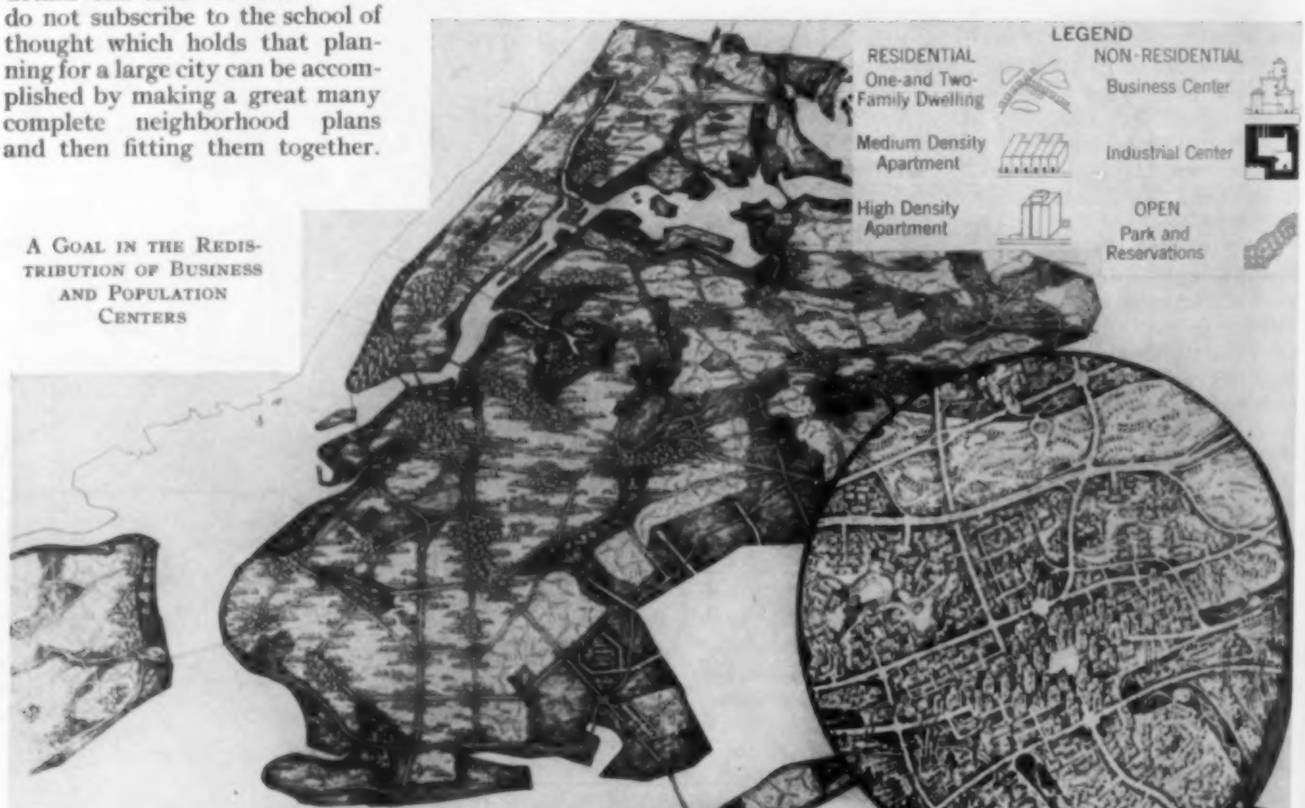
Under the terms of the New York State Public Housing Law, the Commission is required to pass upon all sites for public housing projects, and to review them in their relation to the Master Plan. It was therefore advantageous to have definitely established areas within which such projects should be built, as a guide both to the Commission and to the Housing Authority. Needless to say, these areas are also suitable for other types of residential development for higher income groups.

For technical reasons arising out of the charter provisions, the Commission has found it necessary to do a certain amount of piecemeal planning, involving the fixing of areas within which various public buildings, notably schools, should be built, and to adopt these areas as parts of the Master Plan. This procedure was considered desirable because a comprehensive Master Plan of public building sites, present and future, cannot be developed without considerable expenditure of time. It is therefore essential to consider the sites of immediate future projects as individual items, each to be studied on its own merits and related in so far as possible to the probable future plan of the neighborhood or locale to be served. More than 75 such items have been handled in this way. In principle we believe in city-wide planning to establish a basic framework into which planning details can later be fitted. We do not subscribe to the school of thought which holds that planning for a large city can be accomplished by making a great many complete neighborhood plans and then fitting them together. The adoption of individual building sites and areas as parts of the Master Plan has therefore constituted an exception to our usual policy.

In making a land-use plan for the future, it is wise to assume a somewhat larger population than is likely to be realized. A plan slightly too broad in scale can readily be contracted. On the other hand, a short-sighted plan which fails to foresee the full extent of population growth is difficult to revise upward. Present evidence indicates that the population of New York is not likely ever to exceed 9,000,000, and the probability is that the maximum figure will be more nearly 8,600,000 or even somewhat less. Whether the 1940 population of 7,455,000 will increase steadily to some such total as 8,600,000, or whether the city will continue to grow for a time and then start diminishing in population, eventually reaching substantial stability below the peak, cannot be determined with any degree of accuracy. For the purpose of the Master Plan it is sufficient, at this time, to assume that provision should be made for adequate work and living space for a maximum of 8,600,000 people, plus additional working space for those who live outside the city but are employed within its limits.

The Master Plan of Land Use is properly described as a stage in physical planning. Provisions of the charter imply that much work in social and economic planning must also be done. Even the more elementary concepts of physical planning must rest upon a foundation of social and economic studies. The assumptions made concerning the way in which people will want to live, the ecological pattern of the city, and the extent and kind of opportunities for employment, determine the form of the physical plan.

The social and economic fields are less susceptible of scientific prediction than the physical field. Nevertheless, it seems safe to assume that New York will continue



A GOAL IN THE REDISTRIBUTION OF BUSINESS AND POPULATION CENTERS

to be one of the most important cultural and educational centers of the United States. It also seems reasonably sure that New York will remain the banking and financial capital of the United States, although its dominance may decrease somewhat as the result of current trends toward increasing government participation in public and private financial operations. New York is the largest and busiest port in the country and may be expected to maintain its relative position, although not necessarily its former proportion of foreign and coastwise shipping.

In the field of manufacturing, which is so closely related to shipping by water, rail, and road, there seems little reason to fear any substantial diminution of activity. Certain types of industry, particularly heavy manufacturing of various kinds, have recently tended to move away from the city. Over a long term, however, shifts in type and kind may continue to take place without decrease in the total number of plants, value of products, and extent of industrial employment. New York is best fitted for light manufacturing; for industries where style and seasonableness are principal characteristics; and for those where a large reservoir of skilled seasonal workers is essential. No other city can meet these conditions in like degree.

TRUCKS MERIT CONSIDERATION IN HIGH-SPEED PLANS
A Perhaps Not Too Fantastic Concept of an Express Highway Through an Industrial District

The civilized world has long marveled at and envied the high standard of living which has developed and become an accepted fact in the United States. As long as the productive capacity and individual earning power of workers can keep pace with scientific discoveries and their commercial application, there should be an increasingly higher standard of living. Certainly, in making a plan for the City of New York, the Commission cannot do otherwise than assume that order in the affairs of men will in time prevail, and that higher and better standards of living will continue to be desired by the people and will lie within their power to achieve.

Concerning the specific problem of the future pattern of land use, the Commission has endeavored to make ample provision for the various different types of dwelling that the people of New York have been observed to want. Thus it is assumed that the city of the future should have large areas devoted to apartments. Some of these might be of the cliff-dweller type, but most of them would be so designed as to provide air and light and open space and similar amenities, which are now found in only a small handful of the best-designed developments. Large areas must also be set aside for row houses and small free-standing homes, for the desire to own a home is deep rooted in the thinking of a vast number of families. It is obvious that great masses of apartment buildings and rows of little houses and private gardens should not be mixed in an unplanned and unregulated hodgepodge. Rather the locations and relationships of these units to each other should be carefully worked out as a part of a rational new pattern. Such a rational relationship is intrinsic in the conception of the future city that the land-use plan presents.

In order to reduce the amount of time that the average New Yorker must spend traveling to and from business, the Commission anticipates that both business and industry will be further decentralized within the limits of the greater city. This involves increasing the space for existing principal business centers outside Manhattan and providing for the growth of new secondary business and industrial districts. In New York, business has usually sprung up and flourished where transit lines cross. Thus, the most effective encouragement for new centers would be to produce new focal points of transit lines, by constructing one or more new routes that would intercept the established subways. These focal points would be within walking distance of the homes of many of the people who work in them.

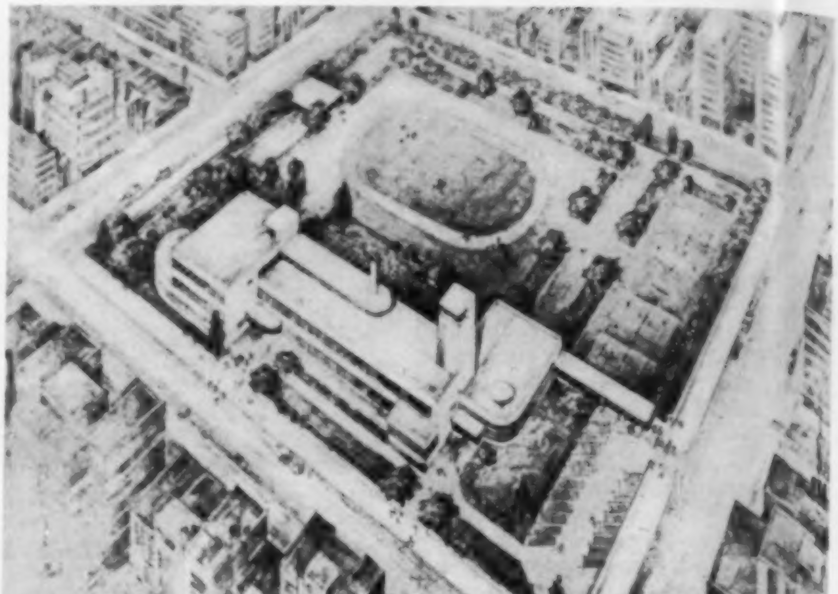
There should also be a concerted effort to reconstruct those run-down inlying residential sections that are close to long-established centers of employment. These are the old residential neighborhoods, many of which have deteriorated into slums. If they are not rebuilt, there can be no sound city plan. Most of these slum areas have the best locations in the city for residential use. They cannot be abandoned and are too expensive to be acquired for public use. Nor would such solutions be sound in any case, for these are the areas in which people should live—not under the unfortunate conditions which they endured in the past, but with all the improvements that they have sought to secure by escaping to newer but less favorably situated districts.

In the process of building up residential communities and encouraging the development of semi-independent satellite centers, it is evident that the present prevailing characteristic of scattered vacant lots should be corrected. Vast areas with only a few houses in each block, interspersed with weed-grown lots, cannot be admitted as part of a long-range plan. Land not needed for the more intense forms of private development should be consolidated in tracts suitable for playgrounds, parks, farms, and other types of extensive use, both public and private.

In order to secure more open space and, at the same time, to separate districts of different types of use, the Commission suggests the principle of gradually developing park belts, park buffer strips, and reservations of open space. In addition to public parks, express highways, airports, military reservations, and possibly some wooded areas would be included. The Master Plan of Land Use suggests the eventual interconnection of existing open areas. In general, a gradual reduction of densities in residential neighborhoods is believed to be desirable without going to the opposite extreme of spreading the population too thinly over the city's area. The Commission has completed studies of the costs to the city involved in the development of residential areas of various types at near-in and outlying locations. It seems

reasonable to expect that most of the existing substandard areas, with their old-law tenements, will be eliminated within not much more than one generation.

Similarly, the present "new-law" apartment areas, which have very high densities, should eventually be rebuilt with more light, air, and open space, and less concentration of tenants. The densities of population contemplated under the proposed land-use pattern not only are less than are now legally permissible under the multiple-dwelling and zoning laws, but in most built-up areas are less than actually exist at the present time. Recent trends in building design and site planning indicate that obsolescence of existing structures may proceed faster than has been the case to date. It is expected, therefore, that the process of rebuilding will take place not lot by lot as in the past, but by whole blocks and groups of blocks at a time. A better opportunity will thus be given to achieve residential communities complete with every facility requisite to a satisfactory neighborhood. As all this can be done in areas that are already close to places of employment, it may be termed a "recentralization" of the residential pattern, which in recent years has shown a tendency toward excessive dispersion. This recentralization will save the city the cost of duplicating and extending public services in areas that do not need to be developed at this time, as they are less well situated than the older areas which have been permitted to decay.



TYPICAL SCHOOL OF THE FUTURE, WITH APPROPRIATE PARKING AND ATHLETIC FACILITIES

The Master Plan of Land Use has been prepared in two stages, so that it will be easier to visualize gradual progress through the years. It should be emphasized that the "first stage" is an intermediate step, a logical outgrowth of the unordered pattern of today. It may be expected that the "second stage" could gradually evolve from the first. This is not an "ultimate" plan—there is no ultimate plan, for the city will always be changing. The plan itself has purposely been kept general instead of precise and detailed. We have avoided making exact lines of demarcation between areas designated for different types of uses. Such lines are the province of zoning maps, which always refer primarily to present regulations and should be changed as more and more of the Master Plan of Land Use can be effectuated.

The Commission has devoted a great deal of study to preparing a city-wide Master Plan of Express Highways, Parkways, and Major Streets (Fig. 1). The plan shows a framework of express highways so laid out that no part of the city is more than a mile and a half from one of these facilities. A typical trip of 13 miles would thus involve a maximum of 3 miles on surface streets, at 12 mph average speed, and 10 miles on express highways at 40 mph. Such a trip would thus take 30 minutes. An important feature of the plan is that practically all future express highways are recommended for construction and use by both passenger and commercial vehicles. Commercial traffic, in the opinion of the Commission, must be able to flow freely, and is entitled to just as much consideration as passenger vehicles.

This part of the Master Plan also shows a comprehensive framework of major streets, interconnected with the express routes. At a later stage, secondary and permanently necessary local streets are to be added. The Master Plan of Highways naturally accepts the existing facilities considered permanently satisfactory as now laid out on the city map. It also shows recommendations for widening existing streets, and for many entirely new streets and highways on new rights of way, which have not as yet been officially mapped or acquired. There are now 40 miles of existing express highways and about 72 miles of existing express parkways. The plan contemplates an additional 131 miles of express highways plus 37 miles of new express parkways.

In the first stage of the Park Master Plan there are shown desirable properties known to have been legally acquired as park land, as well as other properties now used for park purposes, although their present legal status or ownership requires further official action. The first stage of the Master Plan of Schools embraces all those fireproof school buildings which must be considered part of the permanent plant of the Board of Education. Nonfireproof buildings are omitted as they must be replaced within the shortest term of years consistent with the financial capacity of the city.

In three years we have managed to delimit and define objectives and procedures and to bring some important parts of the Master Plan forward and through the stages of preparation, public hearing, and adoption. The task is far from done, but the groundwork—a pattern for the future—is now laid.

The City Planning Commission has had the benefit of many helpful suggestions from the borough president's offices and other city departments, as well as from numerous private agencies and individuals. The membership of the Commission is as follows: R. G. Tugwell, chairman; John C. Riedel, M. Am. Soc. C.E.; Arthur V. Sheridan, Assoc. M. Am. Soc. C.E.; L. M. Orton, Cleveland Rogers, and E. A. Salmon. The writer wishes to acknowledge the guidance that they have given during all stages of the work, and the invaluable assistance of the members of the Master Plan Division staff, particularly E. N. Smith, A. Leshan, and Robert C. Weinberg; Fred W. Tuemmler, Assoc. M. Am. Soc. C.E.; and A. Andrew Boemi, Jun. M. Am. Soc. C.E.

Conformity Between Model and Prototype Tests—Madden Dam Spillway

By P. S. O'Shaughnessy

Associate Engineer, The Panama Canal

Nowhere is it more true than in model tests that "the proof of the pudding is in the eating." In this case the "eating" is the behavior of the prototype. Mr. O'Shaughnessy here reports on extension of the Madden Dam spillway tests previously recorded, the present ones approximating the hydraulic model conditions more closely than did the earlier ones. Discharges, nappes, and pressures show close agreement with model results. This paper was prepared at the request of the Special Committee on Hydraulic Research through its Subcommittee on Conformity of Model to Prototype Behavior, E. W. Lane, chairman. It was presented before the Hydraulics Division at the Society's Denver Convention, July 1940.

Comparisons of test results from model and prototype are usually of interest to engineers. One of the structures for which this has fortunately been possible is Madden Dam on the Panama Canal. A quite complete report covering its spillway flows was given in Transactions for 1938 by Richard R. Randolph, Jr.

Unfortunately, the prototype tests discussed in that paper were all made at lower heads than the lowest head tested on the model. This precluded a direct comparison between model and prototype results. Since that time, however, spillway tests have been made at two heads which correspond closely to the heads tested on the model. A comparison of the prototype tests with the model results is presented here.

No attempt is made to give a complete description of the model or of the prototype, or of the methods used during the testing of both. Mr. Randolph's paper includes a complete description of the structure and of the methods used in the earlier tests. The procedure employed for the later tests was essentially the same.

The Madden Dam model was constructed to an undistorted scale of 1 to 72. The spillway section was built to represent the four 100-ft drum gate openings, with a crest at El. 232.0 and a distance of 440 ft between training walls. The model was tested at the hydraulic laboratory of the Colorado Agricultural College in Fort Collins, Colo. Two of the lowest heads tested, 11.31 and 17.30 ft, were within the range covered later by the prototype tests.

Plan, elevation, and section of the prototype are shown on Figs. 1 and 2. Discharges in excess of 50,000 cu ft per sec at Gamboa, where the Chagres River flows into the Canal, produce currents that are objectionable to navigation. For this reason it was not practicable to lower the four drum gates during all the spillway tests.

Twenty spillway discharge tests were made. Of these, three were at heads between 17.58 and 17.85 ft, and three at heads between 12.75 and 12.95 ft. These six tests

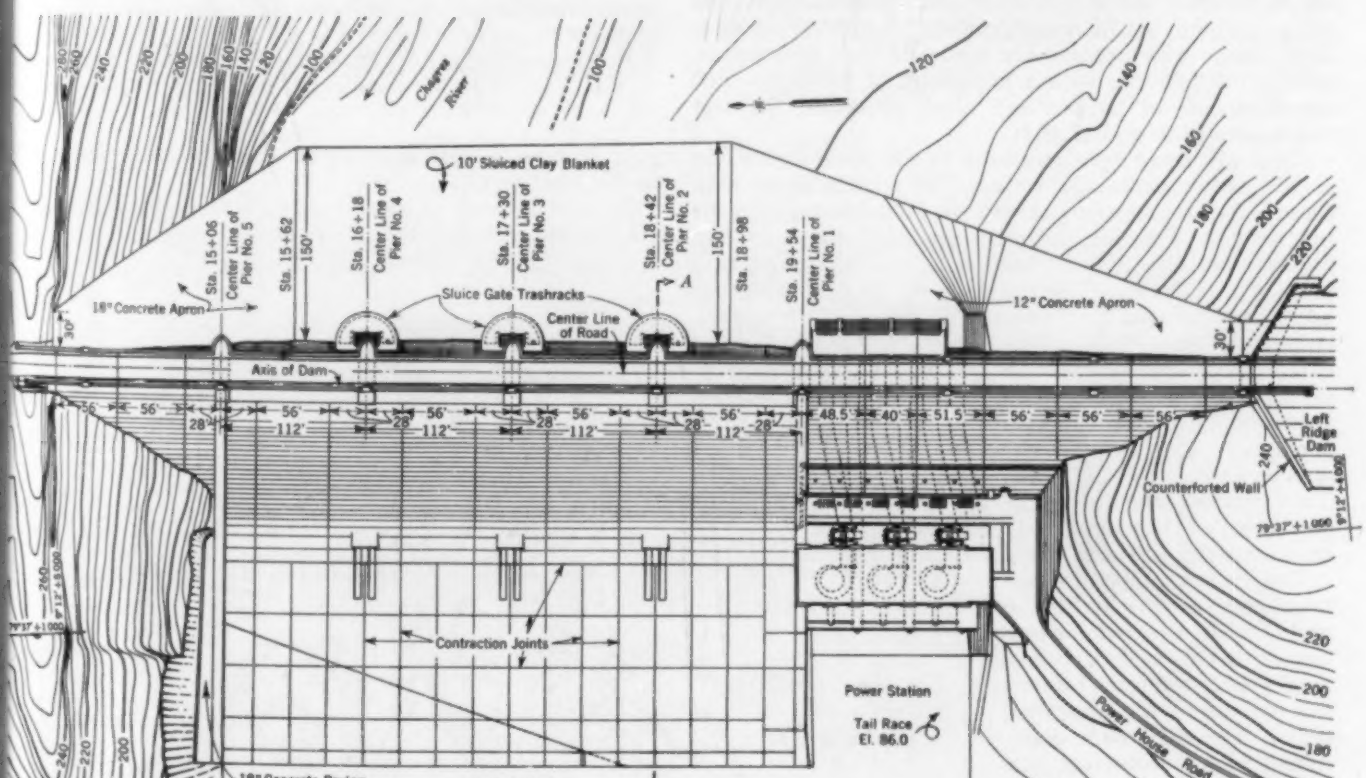
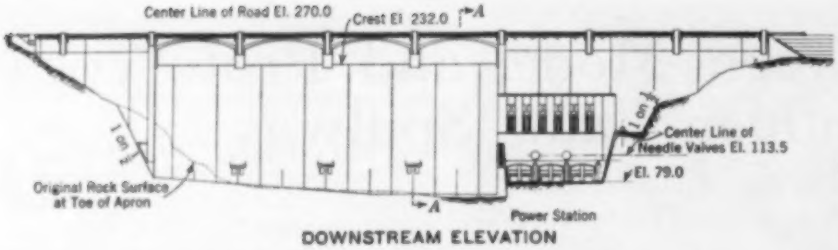


Fig. 1. Plan of Madden Dam



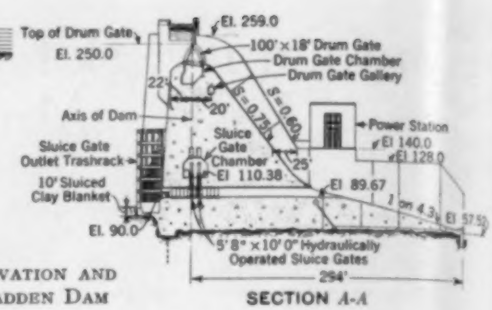


FIG. 2. ELEVATION AND SECTION, MADDEN DAM

were made at heads higher than the lowest head tested on the model. They therefore permit a direct comparison between model and prototype. A tabulation of the results is given in Table I.

Nappes were measured by means of heavy plumb bobs attached to calibrated steel tapes. Two crews worked simultaneously during the tests, taking readings along the drum-gate axis at 2-ft intervals. The average time for a complete set of measurements was about 11 minutes, during which period the reservoir level dropped an average of 0.025 ft, with a maximum of 0.040 ft. For measurements of nappes and crest pressures, the test heads were 12.98 and 17.46 ft.

TABLE I. DATA ON TEST RUNS, MADDEN DAM SPILLWAY

Run No.	Reservoir El.	Head Over Crest, Ft	Drum Gate Discharge, Cfs	No. of Drum Gates Lowered
1	249.85	17.85	24,580	1
2	249.73	17.73	23,970	1
3	249.58	17.58	24,350	1
4*	248.90	6.90	24,090	4
5	244.95	12.95	16,080	1
6	244.85	12.85	16,090	1
7	244.75	12.75	15,660	1
8	233.19	1.19	1,540	4
9	234.52	2.52	4,870	4
10	233.91	1.91	730	1
11	238.63	6.63	22,810	4
12	239.04	7.04	24,720	4
13	238.54	6.54	21,930	4
14	238.46	6.46	21,480	4
15	238.02	6.02	18,920	4
16	237.96	5.96	18,690	4
17	236.88	4.88	13,640	4
18	236.82	4.82	13,530	4
19	236.66	4.66	13,350	4
20	236.60	4.60	13,020	4

* During Run 4 the top of the drum gates was at El. 242.0. For all the other runs the drum gates were lowered to the crest, El. 232.0.

Crest pressures were measured in the same manner as in the earlier prototype tests. The results agree with these earlier tests as well as with the model tests. On the upstream face of the dam, the recorded pressures are higher than the hydrostatic pressures. Over the crest the pressures decrease and become less than those indicated by the measured shape of the nappe. Differences between hydrostatic pressures and hydraulic gradients increase with the head. The vacuum on the downstream side of the crest also increases with the head.

Results of the measurements are shown in Figs. 3 and 4. In the comparison curves between model and prototype, the model points are plotted to the prototype scale. Pressures were determined with piezometers, and profiles by point gage on the model and by plumb bob on the prototype.

In Fig. 5, showing the relationship between the coefficient of discharge and the effective head over the crest, the curve marked "original prototype" was drawn from data collected during the early prototype tests, in all of which the heads were below 8 ft. These data were considered insufficient for definite conclusions at the time they were obtained.

PHOTOGRAPHS INDICATE DISTURBANCES

The curve labeled "revised prototype" shows the results of later prototype tests. Photographs taken of prototype flow against an end and an intermediate spillway pier at heads of 8.0 and 17.7 ft show that for the higher head there is much more disturbance in the flow against the end piers than against the intermediate ones. An end gate was tested on the prototype whereas the discharge tests on the model were made on four gates operating simultaneously. Thus, while model coefficients are the average values for the four gates, prototype coefficients are based on results obtained from a single gate having smaller discharges than the corresponding model discharges.

TABLE II. APRON VELOCITIES, ONE-GATE AND FOUR-GATE OPERATION

No. of Drum Gates Opened	Head, Ft	Discharge, Cu Ft per Sec	Maximum Velocity Before Jump, Ft per Sec	Bottom Velocity at End of Apron, Ft per Sec
1	17.40	23,840	81.7	29.9
1	12.90	16,080	79.2	23.1
4	7.78	31,800	77.0	0.0
4	6.02	20,650	71.5	0.0

It is of interest to note in Fig. 5 that the discharge coefficients for the 13-ft head checked the model coeffi-

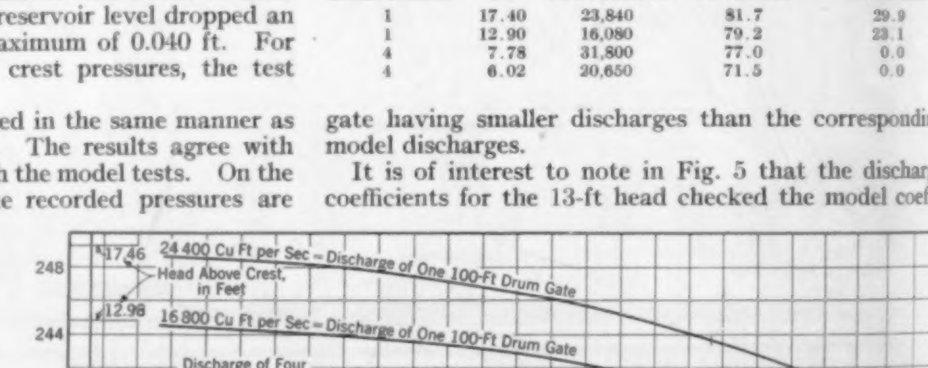


FIG. 3. NAPPES AT VARIOUS HEADS

cients very closely, while those for the 18-ft head were lower. The writer cannot explain this divergence.

No direct comparison of apron velocities and pressures is possible from the model tests and the prototype tests under discussion since the one-gate prototype operation did not permit the formation of the hydraulic jump over the full length of the apron. However, Table II furnishes corroboration of the conclusion drawn from the model tests that four-gate operation is preferable.

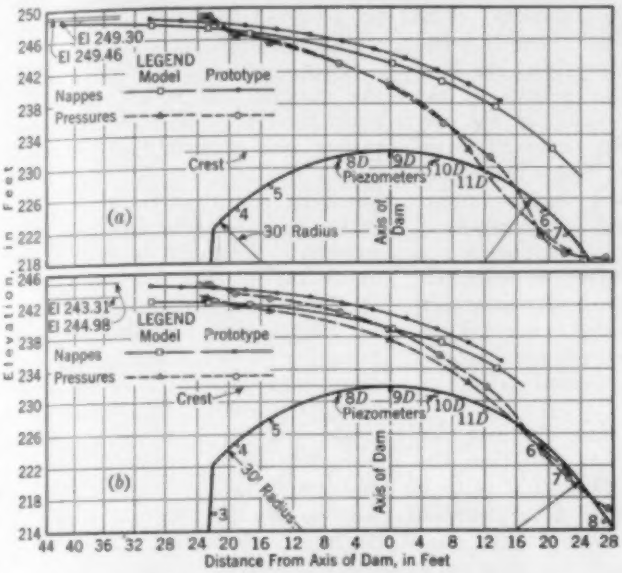


FIG. 4. COMPARISONS OF NAPPES AND PRESSURES
(a) Model Head, 17.30 Ft; Prototype Head, 17.46 Ft
(b) Model Head, 11.31 Ft; Prototype Head, 12.98 Ft

The effect of one-gate operation is shown in Fig. 6. Since the hydraulic jump does not form over the full width of the apron, and since there are also high velocities on the apron, considerable eddying occurs. This does not take place when all the gates in the spillway are being operated simultaneously.

From these investigations a number of conclusions may be drawn:

1. To obtain the best conditions for the dissipation of energy, the hydraulic jump should be formed along the full width of the apron. This will not occur unless the four drum gates are operated simultaneously and discharge approximately equal amounts of water. This conclusion is borne out by the prototype tests.

2. The prototype values for pressures on the crest and for the shape of the nappes check the model test results.

3. The prototype discharges compare well with the model discharges. The difference in results is not considered excessive since the discrepancy is well within the limit of observational error.

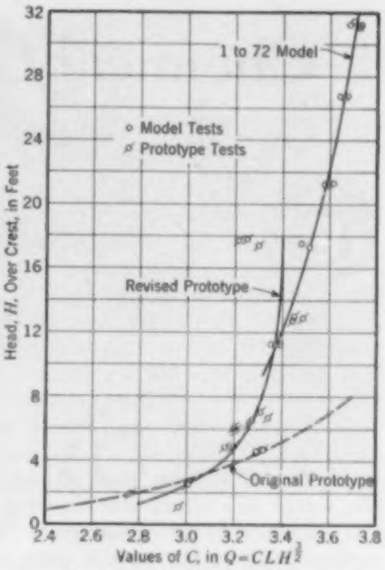


FIG. 5. CREST DISCHARGE COEFFICIENTS

The spillway tests discussed here were made under the direction of E. S. Randolph, designing engineer, and R. Z. Kirkpatrick, chief of surveys. I. F. McIlhenny, assistant engineer, was in direct charge of the field and office work.

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FIG. 6. EFFECT OF ONE-GATE OPERATION ON BANK AND BELOW APRON
Discharge, 16,100 Cfs; Head, 12.9 Ft

Chemical Composition of Ground Waters

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Hand in hand with the development of our resources goes an increase in the value of ground water. The source, distribution, and chemical composition of ground water affect the lives and industry of large groups of the population. In this fact lies the importance of the following paper presented by Professor Huberty before the Water Supply, Plumbing, and Sanitary Engineering Section, School of Government, of the University of Southern California. Although Professor Huberty is primarily concerned with the chemical composition of ground water as related to agriculture, he also discusses the more general aspects of water characteristics in daily life.

The importance of ground-water basins as reservoirs for water is well known to all. The specialty of the individual, however, may influence his opinion as to what constitute the desirable chemical characteristics of a water. The sanitary engineer's first consideration is what effect the water will have upon the health of its users; the industrialist is interested in how the water will affect machinery and the product he manufactures; the agriculturist is concerned with the effect of the water upon his soil and the crops he grows. As one who is closely associated with the last group, the writer will deal more with the importance of chemical composition as related to agriculture than with domestic and industrial uses. As a matter of fact, by far the larger part of the water pumped from the ground-water basins of Southern California is used for irrigation.

Ground waters have been roughly grouped into three classes, depending upon the manner in which the water passes through or is stored in the basins. "Pore water" is held between grains in alluvium and sedimentary formations; "fissure water" exists in the joints and fissures of rock masses; and "cavern water" is found in solution caverns and in openings existing in lava formations. There are other forms of ground water, but they are of little importance as a source of pumped supply.

The nature of the water-bearing material and the length of time the water has been in contact with it may greatly influence the chemical composition of ground water. The rate of water movement through rock formations is affected by the size of the conducting channels, whereas with alluvium the size of the individual grains is a dominant factor. In "The Rate of Movement of Underground Waters" (U.S. Geological Survey Water Supply Paper No. 140, published in 1905), C. S. Slichter described measurements he had made of underflow at the Narrows of the Rio Hondo and San Gabriel River about 10 miles east of Los Angeles, and at the Narrows of the Mojave River near Victorville where the gradient of the water plane was about 20 ft to the mile. He found velocities up to 50 ft for 24 hours. The material through which the water moved was coarse textured so the rate was many times higher than the average rate of water movement in ground-water basins.

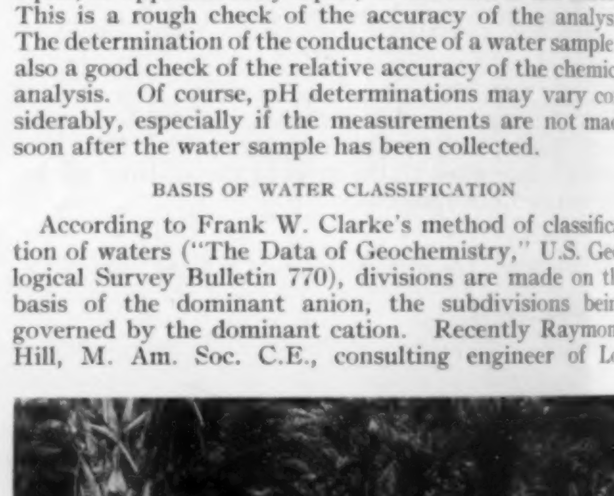
As yet identical terms for the chemical composition of water are not universally used by both engineers and chemists. Engineers are prone to use the terms, parts per million (ppm) and grains per gallon, which are gravimetric measurements of the salts present, but are not measures of the chemical values. Often the various radicles are grouped together in an arbitrary manner. This practice, which is a bad one, is giving way to the expression of the radicles as independent units. Chemists have long used the term "milliequivalents per liter" to express the ionic concentration of the various constituents. Recently the term "equivalents per million" has been proposed. It is hoped that this or some other suitable term will be adopted by both chemists and engineers.

Since methods for determining the concentrations of the various constituents present in water are rather well standardized, they will not be discussed here. Rather, the question arises as to what constitutes an adequate analysis. The answer to this will depend in part upon the use that is to be made of the data. A general purpose analysis might well include the determination of pH, conductance, calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, and nitrate. If the water is to be used for irrigation the determination of boron is essential, while if it is to be used for domestic or stock purposes the determination of iron, arsenic, fluoride, and other constituents might be highly desirable, together with certain physical and bacteriological examinations.

The sum of the milliequivalent cations should be equal, or approximately equal, to the sum of the anions. This is a rough check of the accuracy of the analysis. The determination of the conductance of a water sample is also a good check of the relative accuracy of the chemical analysis. Of course, pH determinations may vary considerably, especially if the measurements are not made soon after the water sample has been collected.

Basis of Water Classification

According to Frank W. Clarke's method of classification of waters ("The Data of Geochemistry," U.S. Geological Survey Bulletin 770), divisions are made on the basis of the dominant anion, the subdivisions being governed by the dominant cation. Recently Raymond Hill, M. Am. Soc. C.E., consulting engineer of Los



Irrigation of Date Orchard with Well Water in Coachella Valley, Calif.

Angeles, worked out a diagrammatic method for plotting chemical analysis (June 1941 issue of PROCEEDINGS). Of the cations, potassium is seldom found in our local ground waters in concentration greater than a few parts per million. In the case of the anions, nitrates are usually low. The concentration of this ion is watched carefully by sanitary engineers as it is an indicator of sewage contamination. In a survey of a ground-water basin in northern California there were found two wells, the waters of which contained over 120 ppm of nitrate. Bacteriologic examination of the water did not disclose the presence of B.coli. Some ground waters in the Indian Wells section of Coachella Valley, California, have as high as 200 ppm of nitrates. We have evidence to show that these high nitrates are the result of decomposition, under irrigation conditions, of organic matter that accumulated in the mesquite forests prior to the artificial application of water. The application of large amounts of water leached the nitrates down to the water-bearing strata, which were approximately 140 ft below the ground surface.

Boron, which is injurious to many plants even in minute quantities, is nevertheless one of the elements essential to plant growth. It is usually not found in high concentrations in normal ground water, but may be present up to several hundred parts per million in water from hot springs. Its effect on plants will be discussed later.

The presence of a large percentage of calcium or magnesium in water is looked upon with disfavor by the industrial engineer, who usually reduces the hardness by precipitation, or by base exchange processes. Irrigationists favor the hard waters as they tend to keep soils permeable.

The upper basin of the Santa Ana River drains a mountainous area of granitic rock, while the middle and lower basins drain low hills and agricultural areas. Reduction in the flow of the stream by diversion, by evaporation, and by transpiration of plants along the river channel, and the recharge by drain waters, tend to increase the salinity of the stream waters. Along with the increase in salinity there is a tendency for the ratio of sodium and chloride to other ions to increase. Wells in close proximity to the stream channel reflect the character of the surface water.

Flood waters are usually of relatively low salt content compared with those of low stream flow. It is highly desirable, therefore, to use every feasible means of recharging ground-water basins with water of low salt content. In the development of Southern California many factors tend to counteract this desideratum.

GROUND WATERS MAY CAUSE PHYSICAL CHANGES IN SOIL

Physical changes in a soil may be brought about by the use of an irrigation water which causes a change in the state of the colloids. The colloids are said to be flocculated when the soil has granular structure and is permeable to water. The dispersed state exists when the colloids are separated, thus resulting in a puddled soil condition. Whether a water will have an injurious effect upon the state of the colloids will depend upon the nature of the base-exchange properties of the soil and upon the character of the irrigation water used. If calcium and magnesium are the dominant cations the soil will tend to remain flocculated, but if the sodium ion predominates the colloids will become dispersed and the permeability of the soil will be adversely altered.

As soil is formed there is a tendency for the more soluble bases to be leached from the soil profile. This accounts for the fact that drainage waters are high in sodium and for the increase in the sodium content of

IRRIGATION OF CITRUS ORCHARD, SOUTHERN CALIFORNIA

ground waters. The soils are, then, usually high in replaceable calcium and magnesium. If irrigation waters high in sodium such as treated water, are used, calcium and magnesium are replaced by the sodium. It has been shown that this reaction is associated not only with the ratio of sodium to calcium and magnesium but also to the total concentration of salts. This change in state results in a marked impairment in soil permeability.

In the utilization of ground water for irrigation there is usually a trend toward an increase in the salt content of the ground water. As water evaporates or is transpired there is left behind a large percentage of salt, as but a small portion is removed by plants. This means that there is a gradual increase in salt content within the soil profile unless sufficient water is added to cause leaching. If the formation is such as to permit the drain water to join the ground water there will be a gradual increase in the salt content of the latter. In artesian basins, or in areas where tile drainage is provided, drain water might not contaminate the water supply.

It has been shown that plant species and varieties vary widely in their boron requirements and boron tolerance. Among the sensitive plants are lemon, grapefruit, avocado, and oranges; semi-tolerant plants include lima beans, sweet potatoes, and cotton; tolerant plants include carrots, lettuce, alfalfa, and sugar beets.

Although much work has been done regarding the effects of salts on plant growth, no definite limit can be set, as many factors modify the tolerance limit. These factors include climate, soil, plant, and amount of water applied. The high alkalinity of sodium carbonate makes it the most toxic of the common constituents. Of all the ions calcium is the least apt to be toxic. Magnesium is potentially slightly more toxic than calcium. A number of investigators have given the following classification of waters with respect to quality for irrigation purposes:

Rating	$K \times 10^5$ at 25C	Total Solids, Ppm	Boron, Ppm	Percentage of Sodium
Excellent	25	175	0.20	20
Good	25–75	175–525	0.25–0.67	20–40
Fair	75–200	525–1,400	0.67–1.00	40–60
Doubtful	200–300	1,400–2,100	1.00–1.25	60–80
Unsuitable	300	2,100	1.25	80

In conclusion it can be said that Southern California possesses excellent ground-water basins, which in general contain water of good quality. It can further be said that it is a function of good government to use every feasible means to prevent impairment of such a great natural resource.

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Verification of Drop-Inlet Hydraulic-Model Studies by Field Tests

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One type of spillway employed by the Wisconsin Soil Conservation Service to carry runoff through small earth dams is the drop-inlet. The hydraulic designs of the many different drop-inlets built in the state since 1933 have been based upon early model studies made at the University of Wisconsin. (See L. H. Kessler's "Experimental Investigation of the Hydraulics of Drop-Inlets and Spillways for Erosion Control Structures," Engineering Experiment Station Series No. 80, University of Wisconsin.) However, to check the validity of the designs, tests were recently made on an experimental field structure and a model on a 1:6 scale approximately. A comparison of the discharge characteristics of the model and the field structure is presented here.

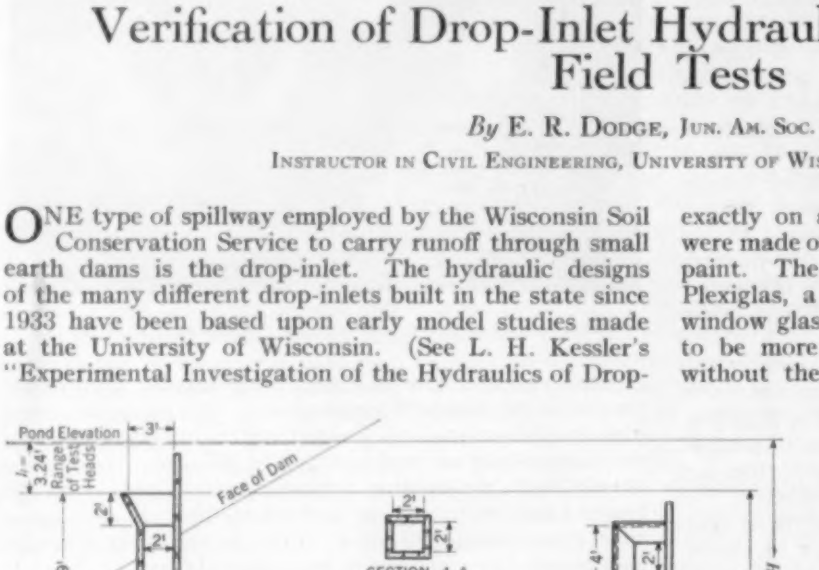

Fig. 1. Experimental Drop-Inlet Spillway near Nelson, Wis.

The experimental field structure (Fig. 1) was built of reinforced concrete at small cost by placing it in an earth dam containing a large drop-inlet constructed for soil erosion purposes. A test was made on the structure by Prof. L. H. Kessler, Assoc. M. Am. Soc. C.E., Prof. J. G. Woodburn, M. Am. Soc. C.E., the author, and engineers of the Soil Conservation Service. A few days before the test the inlet was sealed with a wood cover. Subsequent rains filled the pond, providing a head of over 3 ft on the inlet. The test was started by pulling the cover from the inlet with a truck and block-and-tackle. Pond elevation was determined at 1-min intervals with a float gage reading to 0.01 ft. Average head and discharge over successive 2-min intervals were computed and plotted in Fig. 2 as circles. Flow calculations were based upon pond storage as previously determined by two independent methods: (1) planimetering a topographic map, and (2) allowing the pond to discharge through two 8-in. sharp-edged orifices while the pond elevation was read at measured time intervals.

In Fig. 3 are given dimensions and features of the 4 by 4-in. laboratory model built and tested by Messrs. Bartz and Hilgendorf, as a senior thesis study. The flared inlet and cross section of riser and barrel were exactly on a 1:6 scale. The inlet and outlet sections were made of wood, varnished and coated with aluminum paint. The walls of riser and elbow sections were of Plexiglas, a transparent plastic, while double-strength window glass was used for the barrel. Plexiglas proved to be more satisfactory. Tests were made with and without the 0.81-ft riser section in place. With the riser section the vertical distance from lip to center line of discharge barrel was on the scale of 1:6.28, and without the riser section, 1:10.2. It is thus seen that the model with the riser section was, except for length of horizontal barrel, closely on the scale of 1:6. Without the riser section the model represented the field structure only with considerable scale distortion.

The head-discharge relation obtained for the model with the riser section is shown by solid circles in Fig. 2. Actual test values of head have been multiplied by 6, and discharge by $6^{5/2} = 88.2$, according to the laws of similitude for a scale ratio of 1:6. Data for the model without the riser have not been plotted.

From Fig. 2 it is seen that the results of field and model tests agree. Because the model inlet lip was exactly to a 1:6 scale, agreement would be expected for the range of weir flow (up to 1.7-ft head). It is interesting to note that the tests agree at higher heads also despite slight distortion of scales. Theoretically allowance for this

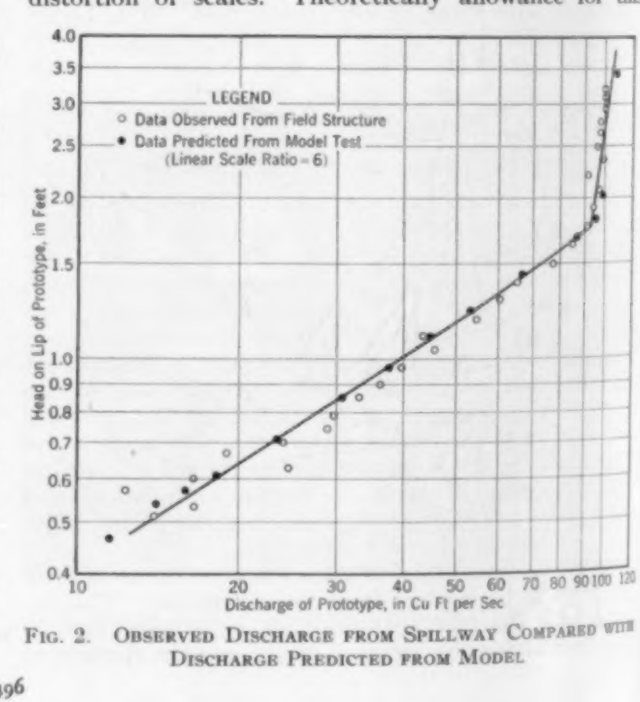

Fig. 2. Observed Discharge from Spillway Compared with Discharge Predicted from Model

scale distortion should be made, as will be indicated in a later paragraph.

Study of the model without the riser section afforded an opportunity to check the validity of full-flow predictions based on tests with distorted scales. Observations of flow through the model indicated that full flow, as determined by the absence of entrained air, began at heads on the lip of about 0.33 ft without riser and 0.50 ft with riser. Full flow continued until the pond surface reached the top of the headwall. At this elevation vortex formation with air entrainment commenced and continued for all higher heads.

For full-flow conditions, application of the Bernoulli theorem between pond and center line of discharge barrel gives:

H = entrance loss + conduit friction loss + elbow loss + exit loss or, for the structures tested (assuming f for conduit loss = 0.01, other coefficients as shown), approximately

$$H = \left(0.1 + 0.01\,\frac{L}{D} + 0.3 + 1.0\right)\frac{V^2}{2g} \quad \ldots\ldots(1)$$

where H = difference in elevation of pond surface and center line of discharge barrel in ft, L = total conduit length in ft, D = cross-sectional dimension of square conduit in ft, V = mean velocity in ft per sec, and g = 32.2 ft per sec². Consequently the ratio of velocities for model and prototype is, assuming that coefficients remain constant,

$$\frac{V}{V_m} = \sqrt{\frac{H[1.4 + 0.01\,(L_m/D_m)]}{H_m[1.4 + 0.01\,(L/D)]}} \quad \ldots\ldots (2)$$

in which subscripts denote model quantities. Then the discharge ratio will be

$$\frac{Q}{Q_m} = \frac{V}{V_m}\left(\frac{D}{D_m}\right)^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

It is thus seen that for full-flow conditions the scale ratios of vertical drop from pond to center line of discharge barrel and total conduit length, as well as scale ratio of conduit cross section, should be taken into account to predict the performance of field structures.

The accompanying Table I presents observed and calculated values for the model tests without and with the riser section, to be used to predict performance of the 2 by 2-ft field structure for full-flow conditions. A head on the lip of 0.33 ft was chosen for the model without riser section because this was the minimum head for full-flow conditions. This corresponded to a head of $H/H_m \times 0.33 = 10.2 \times 0.33 = 3.4$ ft on the field structure lip. The corresponding head on the model with riser section was then $3.4 \times H_m/H = 3.4/6.28 = 0.54$ ft, which also just produced full-flow conditions in the model.

Applying the tabulated values obtained for the field

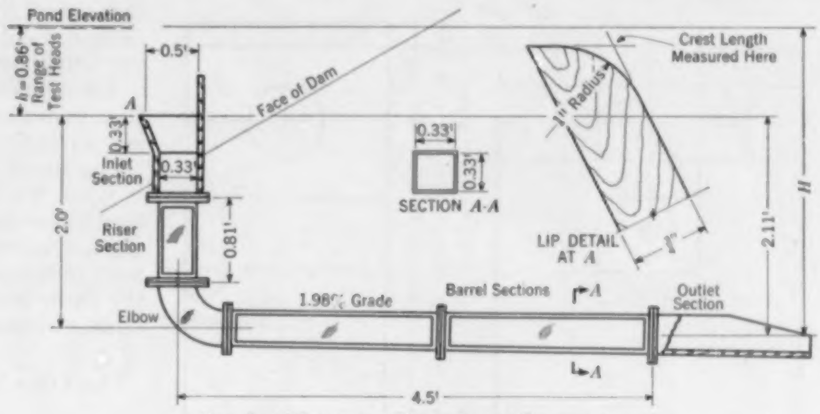

FIG. 3. MODEL OF DROP-INLET SPILLWAY

structure, the discharge is $0.94 \times 108 = 102$ cu ft per sec, from the model test without riser; and $1.20 \times 85 = 102$ cu ft per sec from the model test with riser. The maximum observed discharge of the field structure was about 100 cu ft per sec at 3.24-ft head, but extending the data of Fig. 2 slightly beyond the range of the tests indicates a discharge of about 102 cu ft per sec at 3.4-ft head. Consequently either model test would have yielded essentially the correct value.

If the distortion of scales for the model is neglected, as in the preparation of Fig. 2, assuming simply a scale ratio of 1.6, the results for the field structure would be:

For model without riser section—Head on lip = 0.54×6 = 3.24 ft, and discharge = 1.01 (observed discharge of model at 0.54-ft head) $\times$ 88.2 = 89 cu ft per sec.

For model with riser section—Head on lip = 0.54×6 = 3.24 ft, and discharge = 1.20×88.2 = 106 cu ft per sec (model with riser section).

For all practical purposes the agreement of the second calculation with the field data would be considered satisfactory, but the first calculation does not check out. Hence we conclude that only for slight scale distortion can such simplification be made.

TABLE I. DATA FOR PREDICTING PERFORMANCE OF FIELD STRUCTURE FROM MODEL TESTS, FOR FULL-FLOW CONDITIONS

Model	Total Length Conduit in Diameters	Distance Inlet Lip to Center, Line Discharge Barrel, Ft	Observed Head on Lip, Ft	Total Drop Pond to Center Line Discharge Barrel, Ft	Observed Discharge, Cu Ft per Sec	Ratio of Value, Prototype to Model: D/D_m	H/H_m	V/V_m	Q/Q_m
Without riser section.....	16.8	1.30	0.33	1.63	0.94	6	10.2	3.00	108
With riser section........	19.2	2.11	0.54	2.65	1.20	6	6.28	2.36	85

Shear Strengths of Some Non-Ferrous Metals

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ULTIMATE shearing strengths for non-ferrous metals can be found in handbooks, but the values given are usually average ones for materials not too well defined. On a recent job, the author found it necessary to specify, for the design of shear bolts in certain heavy and slow-moving machinery, a material of known shearing strength available in the locality. The results of a series of double shear tests performed on copper, free-

cutting brass, and tobin bronze rods, $^3/_4$ in. in diameter, yielded ultimate shear values of 30,000, 40,000, and 50,000 lb per sq in., respectively.

A steel fixture was designed to hold the rods while they were being sheared. The dimensions are shown in

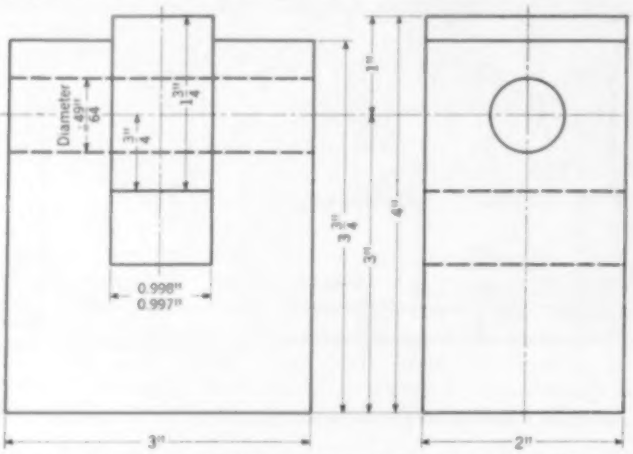

FIG. 1. STEEL FIXTURE DESIGNED TO HOLD RODS WHILE THEY WERE BEING SHEARED

Fig. 1. Twenty-one specimens were tested in double shear by placing them in the oversize holes drilled in the fixture and applying a force to the center head. A Tinius Olsen testing machine rated at 300,000 lb was used in applying the shearing force. Four specimens of each material were grooved in the shearing planes to a diameter of $^1/_2$ in. Of these grooved specimens, one each of copper, brass, and bronze were annealed to determine the effect of heat treatment. Table I lists the results.

It was surprising that annealing the copper rods seemed to increase the ultimate shearing strength about 10%. The $^3/_4$-in. round bars also defied expectations by having only 92% of the ultimate unit shearing strength of the grooved bars. The breaks were not clean and a portion of the cross-sectional area showed copper burrs smeared over it. Apparently there was some flexural stress in spite of the close clearances between the moving parts of the fixture. There was no recognizable yield point prior to failure. It is of interest to note that for this ductile material the ultimate shear value was about 75% of the ultimate tensile strength.

Brass rods, on the other hand, broke clean and showed consistent unit strengths for the machined and for the natural $^3/_4$-in. round rods. Annealing reduced the unit shear strength about 5% but again there was no sharply defined yield point. Shear strength was about 70% of the tensile strength.

Tobin bronze rods acted nearly like mild steel except that annealing had absolutely no effect upon the shearing strength. The full-size rods tested 6% lower than the grooved specimens. No yield point was apparent.

While the number of tests were limited, the results were conclusive enough to convince the author that annealing did not soften the material. The most consistent results were obtained from the brass specimens, and accordingly the shear bolts were designed for this metal on the basis of an ultimate shear strength of 40,000 lb per sq in.

TABLE I. RESULTS OF HEAT TREATMENT ON BOLTS

Material	Composition	Tensile Strength, Lb per Sq In.	Specimen Area, Sq In.	Double Shear Value, Lb	Shear Strength, Lb per Sq In.
Electrolytic copper . . .	Cu, 100%	40,000	0.392	11,900 12,100 11,850	30,300 30,800 30,300 Av. = 30,400
Annealed copper . . .	Cu, 100%	40,000	0.392	12,950	33,000
Electrolytic copper . . .	Cu, 100%	40,000	0.883	24,475 24,600 24,300	27,600 27,900 27,500 Av. = 27,700
Free-cutting brass	Cu, 62% Zn, 35% Pb, 3%	58,000	0.392	15,700 15,700 15,500	40,100 40,100 39,600 Av. = 40,000
Annealed brass.	ditto	58,000	0.392	15,000	38,200
Free-cutting brass	ditto	58,000	0.883	35,000 34,600 34,200	39,600 39,100 38,700 Av. = 39,100
Tobin bronze rod	Cu, 60% Zn, $39^1/_4$% Sn, $^3/_4$%	63,000	0.392	20,050 19,550 19,650	51,000 49,800 50,000 Av. = 50,270
Annealed tobin bronze . . .	ditto	63,000	0.392	19,750	50,100
Tobin bronze rod	ditto	63,000	0.883	41,500 41,700 41,600	47,000 47,200 47,100 Av. = 47,100

Simple Solution for Unsymmetrical Cable Span

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IN texts known to the writer unnecessary labor is used in the calculations of cables suspended at unequal heights, when these are of relatively small sags, and so considered as parabolas. From the equation for a parabola with ends at the same level (see Fig. 1), ordinates may be found readily enough, and the equation presented here determines the span of that parabola, of which the parabola with unequal supports is of course a part.

L_0 = length of span
h = difference in levels at ends
h_0 = $h/2 + S_0$
L = span of parabola with ends at the same level, of which L_0 is a part
S = sag at center of L
S_0 = sag in L_0
H = horizontal component in cable
T = $H/\cos\alpha$
w = weight of cable per foot

Consider the parabola whose chord is L_0. The load normal to the chord is $w\cos\alpha$. The force parallel to the chord of L_0 is very closely $H/\cos\alpha$. The sag normal to the chord is $\dfrac{(w\cos\alpha)L^2}{8(H/\cos\alpha)}$ and S_0 is very closely this result times $1/\cos\alpha$.

$$S_0 = \frac{(w\cos\alpha)L^2_1}{8(H/\cos\alpha)}\,\frac{1}{\cos\alpha} = \frac{w\cos\alpha L^2_1}{8H} = \frac{wL^2_0}{8H\cos\alpha}$$

$$h = S\frac{4L_0(L - L_0)}{L^2};\quad h_0 = \frac{4\dfrac{L_0}{2}\left(L - \dfrac{L_0}{2}\right)}{L^2}S;$$

$$S = \frac{L^2h}{4L_0(L - L_0)} = \frac{L^2h_0}{2L_0(L - L_0/2)}$$

Whence $L = \dfrac{2h_0 - h/2}{2h_0 - h}L_0$; or, since $h_0 = \dfrac{h}{2} + S_0$

$$L = \frac{2S_0 + h/2}{2S_0} L_0 \ldots\ldots\ldots\ldots\ldots (1)$$

First Example. Let $w = 1$ lb; $h = 15$ ft; $L_0 = 600$ ft; $T = 4{,}000$ lb; $\cos\alpha = \cos\left(\tan^{-1} = \frac{15}{600}\right) = 0.9997$, neglected in calculation.

$$S_0 = \frac{600^2}{8 \times 4{,}000} = 11.25 \text{ ft}; \; L = \frac{22.5 + 7.5}{22.5} 600 = 800 \text{ ft}.$$

Second Example. Let $w = 1$ lb; $h = 15$ ft; $L_0 = 200$ ft; $T = 4{,}000$ lb; $\cos\alpha = \cos\left(\tan^{-1} = \frac{15}{200}\right) = 0.9972$, neglected in calculation.

$$S_0 = \frac{200^2}{8 \times 4{,}000} = 1.25 \text{ ft}; \; L = \frac{2.5 + 7.5}{2.5} 200 = 800 \text{ ft}$$

If the h is at the center, $S_0 = \dfrac{400^2}{8 \times 4{,}000} = 5$, and $L = \dfrac{10 + 10}{10} \times 400 = 800$ ft.

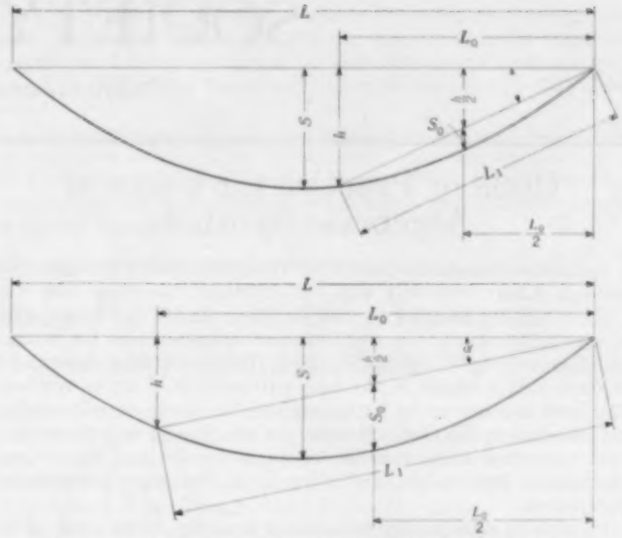


FIG. 1. UNSYMMETRICAL CABLE SPAN OF SMALL SAG APPROXIMATING A PARABOLA

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Saturating an Earth Dam

TO THE EDITOR: In his article, in the April issue, on "Time Required to Saturate an Earth Dam" Mr. Karpoff has based his method upon conditions existing after the completion of saturation. During saturation of an embankment, however, flow is in the unsteady state, and the gradients are not the same as those existing after the development of complete saturation. For this reason, it is desirable that computations of the theoretical time required to saturate an earth dam be based upon conditions existing during saturation.

During the saturation period, the flow pattern is in a state of constant change. Nevertheless, it is the belief of the writer that the flow net can be used to advantage in securing a reasonably good approximation of the progress of the saturation front during saturation of an embankment. The basic procedure, applied to Mr. Karpoff's numerical example, is illustrated in Fig. 1. In a series of increments the saturation line is moved through the embankment in such a manner that the relative movements during any increment are proportional to the gradients along the saturation front. The gradients at successive points along the base are used in computing the time required for saturation.

The time required for an increment of movement of the saturation front is determined from the following relationship:

$$\Delta t = \frac{\Delta 1}{U} \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

in which the terms have the following significance:

Δt = time required for saturation front to move distance, $\Delta 1$, along base of dam

U = velocity of saturation front at base of dam $= \frac{ki'}{V}$. (V = correction factor; i' = "effective" gradient = true gradient corrected for convergence; k = coefficient of permeability)

By summation, the total time,

$$T = \sum \Delta t = \sum \frac{\Delta 1}{U} = \frac{V}{K} \sum \frac{\Delta 1}{i'} \ldots\ldots\ldots\ldots (2)$$

In the numerical example, the following values were given:

k = 3.37 ft per year; V = 0.007

The sum of the ratios, $\frac{\Delta 1}{i'}$ was determined to be $\sum \frac{\Delta 1}{i'} = 230$.

Inserting the above values in Eq. 2, the time required for saturation to reach the toe of the dam is found to be:

$$T = \frac{0.007}{3.37}(230) = 0.48 \text{ year}$$

After the saturation line reaches the toe, additional time will be required for the development of complete saturation.

As suggested by Mr. Karpoff, measurements of the progress of saturation in full-sized embankments are needed to check theoretical computations. Entrapped air can have tremendous influence upon flow through soil. Likewise, capillarity and other factors undoubtedly influence the progress of saturation. Until the many factors influencing seepage have been checked by observation of the progress of seepage through actual embankments, theoretical estimates of the rate of saturation should be considered rough indicators of the probable rate.

H. R. CEDERGREN, Jun. Am. Soc. C.E.
Assistant Engineer, U.S. Engineer Office
Portland, Ore.

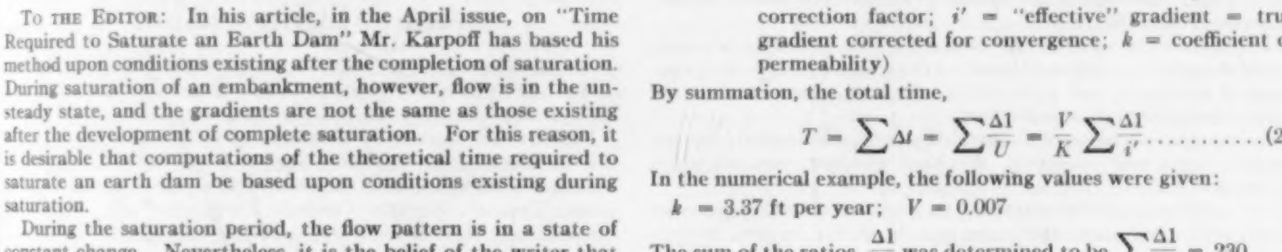


FIG. 1. SUGGESTED METHOD FOR DETERMINING THE PROGRESS OF SATURATION THROUGH AN EMBANKMENT

SOCIETY AFFAIRS

Official and Semi-Official

Code of Practice for Users of Algebraic Symbols

AMERICAN Standards Committee (with the Society's cooperation through Albert Haertlein and J. C. Stevens, Members Am. Soc. C.E.) is rapidly bringing to fruition the results of five years spent in standardizing "Letter Symbols and Abbreviations for Science and Engineering." One must admit the far-reaching importance of correcting disorder in the past careless use of letter symbols. The joint committee on letter symbols has made an outstanding contribution to this end. Members of the Society will be particularly interested in the symbols for use in the fields of Physics and Mechanics, Hydraulics, and Structural Analysis, now nearing completion.

Possibly of even greater importance, however, is the effort of the committee to point a "direction beam" forward into the future, suggesting rules for selecting new symbols that will tend to become self-standardizing. This was the underlying purpose of "General Principles of Letter Symbol Standardization." This "code of practice" will appear at the head of every list of letter symbols issued by American Standards Association. Its influence is also being felt outside the sphere of ASA activities, as, for example, in the Manual of Engineering Practice 22 (Soil Mechanics Nomenclature) which was issued last month.

The official wording of these principles is as follows:

1. Symbols used should be defined clearly. When a table of symbols is not given, it is desirable to make reference to the standard lists from which the symbols are taken. The many numbers, letters, and signs which are similar in appearance should be distinguished carefully.

2. A *letter symbol* is a single character, with subscript or superscript if required, used to designate a physical magnitude in mathematical equations and expressions. Two or more symbols together always represent a product.

Letter symbols are to be distinguished from abbrevations, mathematical signs and operators, graphical symbols, and chemical symbols:

(*a*) *Abbreviations* are shortened forms of names and expressions employed in texts and tabulations and should not be used as symbols in equations.

(*b*) *Mathematical signs and operators* are characters used with letter symbols to denote mathematical operations and relations.

(*c*) *Graphical symbols* are conventionalized diagrams and letters used on plans and drawings.

(*d*) *Chemical symbols* are letters and other characters designating chemical elements and groups.

3. The *same symbol* should be used for the *same physical magnitude* regardless of the units employed and regardless of special values occurring for different states, points, parts, times, etc. Units or special values may be distinguished when necessary by subscripts, superscripts, or by upper and lower case letters when both are specifically included as symbols in a standard list. The units used should be indicated when necessary. Sometimes different symbols are used for the components of a vector.

4. A *subscript* preferably should be a single character. It is commonly employed to indicate constancy of a particular physical magnitude, such as pressure or temperature, when there are other variables. A multiple subscript, sometimes divided by a comma, refers to more than one state, point, part, time, etc. A subscript should not be attached to a subscript. Further uses of subscripts are listed in Principles 3 and 6.

5. A symbol with a *superscript*, such as a prime (′) or a second (″), should be enclosed in parentheses, braces, or brackets before affixing an exponent. A complicated exponent (or any other expression frequently repeated) may be replaced by a single symbol selected to represent it. Reference marks should not be attached to symbols. Further uses of superscripts are listed in Principles 3 and 6.

6. *Conflicts* which would occur when different physical magnitudes are assigned the identical symbol in the same or different standard symbol lists may be resolved in one of the following ways:

(*a*) For one or more of the conflicting uses, the given symbol may be employed with subscript or superscript selected by the author.

(*b*) If one of the magnitudes has an alternate symbol in a standard list, it may be used.

(*c*) A slight change in the name of the magnitude may remove the conflict. For instance, one may use L for "length of radius" when r "radius" conflicts with r used for another magnitude.

7. *Unlisted Magnitudes.* To symbolize a special value of a listed magnitude, see Principle 3. The symbol chosen by an author for a physical magnitude not appearing in any standard list should be one that does not already have a different meaning in the field of the text.

8. *Typography.* Letter symbols, letter subscripts, and letter superscripts, whether upper or lower case, should be printed with italic type unless definitely specified otherwise. On manuscript this is indicated by underlining each symbol which is to be italicized. Special types, such as Old English and type that is currently used for vector magnitudes, should be avoided for scalar magnitudes. When special type is used for vector magnitudes, the same italic letter should be used for the corresponding scalar magnitude. Vertical Arabic numerals should be used as coefficients in equations and in subscripts and exponents. Bars, dots, and other modifying signs and operators should be used in the manner currently recognized by mathematicians.

National Defense Emphasized at Annual Convention

AS THIS ISSUE goes to press, the Seventy-First Annual Convention of the Society is convening in San Diego with the subject of National Defense very much in the foreground.

Registration started on Tuesday, July 22, and by the time of the opening session on Wednesday had reached three hundred. The first session, at the U. S. Grant Hotel, was opened by addresses from C. Wayland Capwell, President of the San Diego Section, and His Honor Percy J. Benbough, Mayor of the City of San Diego. President Fowler then gave the response and annual address, a digest of which is to be found in this issue, on page 459. At lunch, Maj.-Gen. H. B. Fiske, U. S. Army (Retired), delivered an address on "Our Army," and at 2:30 p.m. the Symposium on National Defense started under the direction of Chairman Joseph Jacobs and of Walter D. Binger, chairman of the National Committee on Civilian Protection in War Time.

This was the start of a series of interesting and exciting days where the charm and quiet hospitality of San Diego were felt at every turn. The effort required by National Defense can be taken in stride where the outlook of the San Diego Meeting is maintained. Detailed accounts will appear in the next issue, and succeeding issues will feature a wide variety of papers from the Technical Division sessions.

Self-Appraisal Blanks Get Expanded Use

LAST SPRING, with the cooperation of the Engineers' Council for Professional Development, the Society sent to each of its Juniors a copy of the personal appraisal blank prepared by the ECPD Committee on Professional Training, and published under the title of "Suggestions to Junior Engineers." At the same time copies were sent to the Faculty Advisers of each of the 121 Student Chapters for distribution to the 1941 graduates. It was pointed out to the recipients of these blanks that the questionnaire is not to be shown to anyone; it is simply a check list for aiding the individual to evaluate himself, his education, his present position, and his plan for professional progress.

An interesting repercussion of this effort has come to light. C. B. McCullough, Assistant Chief Engineer of the State Highway Commission of Oregon, has been the Contact Member of the Student Chapter at Oregon State Agricultural College since October 1940. As such he received a copy of the form sent to his Chapter. This impressed him as a valuable stimulus to any young engineer and resulted in his securing 200 copies from the Society for distribution within the Oregon State Highway Department.

Several copies were put in the hands of each supervisor within the department, down to and including resident engineers, with the request that it be made available to appropriate young men under their supervision. Opportunity was also given for collecting suggestions for improving the self-appraisal blank, and one such group of suggestions has already been transmitted to ECPD for study.

This is a thoughtful and commendable move by an engineer in authority on behalf of his "youngsters." In the early stages of his career, the young engineer can benefit greatly from the making of an estimate of his personal situation with a view to avoiding some of the less desirable results of drifting.

Progress in Salary Adjustments Reported by Arizona, Nevada, and Nebraska Highway Departments

As previously reported in these pages during the past 15 months, three Society-sponsored surveys have been made of engineering positions and salaries in the Arizona and Nevada Highway Departments and in the Nebraska Department of Roads and Irrigation. The Society's Committee on Salaries recently inquired as to progress under the three reports, and elicited the following information: The Arizona report, presented March 29, 1940, was adopted by the Arizona State Highway Commission on June 28, 1940. The only change made in the report prior to adoption was to raise the salary range for the lowest subprofessional Grade A from \$80–\$105 to \$100–\$125. The grade specifications as written were adopted without change and the State Highway Engineer was instructed to put all recommendations into effect without delay.

To date, the recommendation to prepare and adopt a merit or service rating system has not been carried out, but the State Highway Engineer reports that some progress has been made in drafting such a system.

Job descriptions have not yet been prepared nor have positions or individuals been allotted to grades other than the original trial allocation of individuals made under the supervision of the Society's representative prior to the completion of the report.

The State Highway Engineer estimated that approximately \$10,000 would have been required to meet fully the requirements in the report. He states that approximately \$4,200 has been requested and secured for this purpose.

"There have been some increases in salaries between the first adjustments noted above (\$4,200) and the making of a new budget. The new budget will carry a number of adjustments and I intend to appoint a committee to go over the report as to classifications, bring the report up to date, and make a new start on individual adjustments that have not been taken care of already."

In response to a request for suggestions for strengthening the procedure that had been recommended, the State Highway Engineer replied, "I have none. The report has stabilized conditions as to engineering positions to a wonderful degree, but in a political subdivision of government, it is a slow process and one must have patience and act when the opportunity presents itself."

The Nevada report was presented to the Nevada Highway Board of Directors October 17, 1940. The grade specifications were adopted unchanged on January 14, 1941. Information to date does not disclose whether a merit rating system and a set of job descriptions have yet been completed.

Positions were tentatively assigned to grades prior to the presentation of the report. From the letter from the State Highway Engineer it may be inferred that these assignments have been accepted and are now in effect.

Reclassification of all engineering employees within the department has been completed with the exception of two office engineers and one field engineer.

With respect to salaries, the Highway Board of Directors specifically excepted the recommended salary schedule when it adopted the reclassifications on January 14, 1941, but since that date "salaries have been adjusted in every instance for all these men with the exception of the three mentioned, and salaries placed above the minimum rate recommended. The salary changes were started in accordance with the reclassifications on April 16, 1941, and completed June 16, 1941. There has been no change in the salary rate of the State Highway Engineer, his Assistant, or the Division Engineer. I do not think that the Board will authorize any change for those people.

"At the present time we are preparing a new chart showing just how the salary compliance has been made as compared with the ideal curve (prepared by the Society representative)."

Asked whether anything had been presented to the Legislature requesting a salary change, State Highway Engineer Allen replied, "I do not anticipate that there will be any change offered in the Legislature [to change the salary of the State Highway Engineer, at present fixed by law at \$5,000]."

In general comment, he stated:

"All in all, I am very much pleased with the whole set-up and feel that it has meant a decided advancement to the engineering profession in this state. The reclassification as outlined has had the effect of steadying employees and I think that since they have received their salary increase they are much more content than they were before. To exceed their present classification and attain a higher grade it is necessary that they obtain more experience, night study, or advancement of some other kind. They all recognize this and are studying in an attempt to make a higher rate."

The Nebraska report, presented to the Governor on April 23, 1941, is being adopted and put into effect piecemeal. The grade specifications were adopted unchanged on April 24. On the same day, the State Engineer was authorized to prepare a rating system which, by July 1, was reported as approximately 50% complete. This was also true of job descriptions.

Assignment of positions to grades has been completed in preliminary form. The final allocation will await the completion of the detailed job descriptions.

In order to expedite the program of salary increases, it was necessary to grade the positions tentatively and to place employees filling those positions at the minimum salary for that grade except where it was evident that the jobs within the grade had some distinguishing difference. In those instances some difference was made between jobs considered as higher or lower within that grade.

The following tabulation indicates the average increases as of July 1, 1941, for the four subprofessional grades and the first four professional grades:

Grade	No. of Employees	Average % Increase		
A	24	5%	Av. 11.5%	Av. 15.5%
B	63	10%		
C	69	15%		
D	2	18%		
1	62	12%	Av. 18.5%	
2	55	18%		
3	67	26%		
4	16	14%		

Some small increases have been approved for engineers in Grades 5 and 6. The State Engineer's salary is fixed by law at \$6,000. (His position is in Grade 7.) During the legislative session just closed, no recommendation was presented to the Legislature with respect to changing this salary, as the Governor felt it was too late in the season to receive proper attention.

In response to an inquiry whether the State Engineer cared to make suggestions that might be helpful to the Committee, he wrote:

"One result of the adoption of the salary schedule has been that employees in the Department who have fallen behind and have remained stationary have been the chief objectors since the salary increases were announced. In other words, we feel it is putting the employees of the Department on their own, and it will be up to them to develop a higher rating individually."

Handbook for Student Chapters

A TWENTY-PAGE pamphlet has recently been issued by the Society on behalf of the 1940 Committee on Student Chapters. At the very outset it is stated that this *Handbook for Student Chapters* has for its purpose "to indicate how students in civil engineering may enrich their college courses by beginning those professional associations and contacts which, continued through life, are invaluable to the practicing engineer."

At the beginning, and most appropriately, is given the Code of Ethics of the Society. With this introduction the student may find in the pages that follow a variety of information on the Society itself, its functioning, its relation to other organizations and to its component parts, the privileges of Student Chapters, the conduct of meetings, and the duties of officers—not to mention other useful suggestions. In the form of appendices appears such valuable supplementary material as the standard form of Student Chapter constitution, suggestions for the annual report of a Chapter, methods of organizing and conducting a regional conference, and a standard constitution for such a conference.

In short, most of the questions that might arise in connection with Student Chapter relations are succinctly covered in this booklet. It is expected to become the standard and to prove of continuing value from a practical point of view. The 1940 Committee on Student Chapters consisted of John H. Porter, E. M. Hastings, C. L. Eckel, Charles Gilman Hyde, and Andrew H. Holt, chairman.

A few pertinent paragraphs from the handbook follow:

"ENTERING THE PROFESSION

"Engineers normally enter the profession through two successive stages: taking a course in engineering at a recognized college of engineering, and then after graduation serving for a period of years in a subordinate capacity under engineers of experience. The college course provides a scientific foundation and a framework in the science of engineering, while the period of assistantship furnishes familiarity with practical details and procedures. The latter, in a general way, corresponds to the internship of the physician, or the clerkship of the young law graduate.

"The professional preparation of engineers is acquired, for the most part, after graduation, but it should be clearly recognized that an engineering course is part of an engineering career. Therefore, one should begin immediately, while still in school, the habits of study, the process of making professional acquaintances, the practice of interchanging ideas with other engineers, the conformity to a code of ethics, and the development of other attitudes and habits intrinsic to the profession. A consciousness that there is a professional side to an engineer's career should be awakened while the more obvious technical side is still holding the center of the stage.

"BEGINNING PROFESSIONAL ASSOCIATIONS

"Professional associations include making friends with others in one's own field, and also with those in related fields, becoming acquainted with technical magazines, and acquiring membership in engineering societies. Professional societies are agencies by which men help each other to advance through group efforts, meetings, discussions, papers, and friendly contacts. A recluse, however talented, who has no such associations, will be handicapped because he will not receive the intellectual stimulation, and the amplification and correction of his ideas that arise from professional associations. Entrance to college should be the first step toward the profession as well as toward the science of engineering, and the two aspects of an engineer's development should proceed simultaneously.

"PURPOSE OF THE STUDENT CHAPTER

"The student chapter of a national engineering society is established to afford the beginnings of professional associations. Experience in preparing, presenting, and discussing papers, comparing impressions of engineering problems, making appraisals of men from their writings, and forming judgments as to the practical aspects of projects thus described contribute to mental development; while the business of conducting chapter activities, holding office, securing outside speakers, visiting works under construction, making reports to the national society, and reading the publications of the society afford those initial contacts with the profession that should be carried on simultaneously with studies in the classroom. The student chapter supplements the work of regular class instruction, and it is the only agency that can bring these values first hand to the student. Student chapters are now established in practically all colleges of engineering of approved standing.

"The Committee on Student Chapters wishes it to be clearly understood that the Chapters are not recruiting agencies for Society membership. Their purpose is to help the student prepare himself for entry into the profession. Whether he joins the Society or not, he should benefit from the activities of the Chapter, and thereby become a better member of the profession.

"Of course it is hoped that qualified graduates will want to become members of the Society because they can see mutual advantages in the relationship, but the Committee is strictly opposed to the employment of any form of pressure tactics to increase Society membership."

Appointment of Society Representative

SHORTRIDGE HARDESTY, M. Am. Soc. C.E., has been appointed to represent the Society on the Welding Research Committee on Engineering Foundation. He Succeeds WILLIAM G. GROVE, M. Am. Soc. C.E., who has been forced to resign because of the pressure of defense work.

News of Local Sections

Scheduled Meetings

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:15 p.m.

SAN FRANCISCO SECTION—Regular dinner meeting at the Engineers' Club of San Francisco on August 19, at 5:30 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on August 4, at 12:10 p.m.

Recent Activities

COLORADO SECTION

At the annual meeting of the Section, held jointly with the Student Chapters at the University of Colorado and Colorado State College on May 12, Robert L. Stearns spoke on the present social and political system. Mr. Stearns is president of the University of Colorado. A special meeting for the purpose of discussing national defense and the labor situation took place on May 28. A committee was appointed to consider various phases of production, resources, and economic adjustment made necessary by the present emergency. The annual picnic, which was to have included an inspection trip to the Fort Collins Water Works, turned into an indoor "fish fry" because of bad weather.

Recent programs of the Junior Association have included talks on the Selective Service program, with special attention to the subject of occupational deferments. On one occasion Ralph Parshall, senior irrigation engineer for the U.S. Department of Agriculture, outlined the history of structures used for measuring water since the design of the venturi flume.

HAWAII SECTION

At a dinner meeting held on May 6 the guest of honor and speaker was Prof. Charles O'Rourke, of Cornell University, who analyzed the failure of the Tacoma Narrows Bridge. Professor O'Rourke also discussed earlier suspension bridge failures in this country and Europe, calling attention to parallel factors probably contributing to the failures. The speaker on June 10 was E. S. Thayer, senior structural engineer in the U.S. Engineer Office and co-author of a textbook on arch design, who discussed the historical origin of the arch, the various types of arches, and methods of design. There was also a discussion on the subject of establishing a Junior forum within the Section, and a committee was appointed to formulate plans for such a forum.

KANSAS CITY SECTION

At this joint meeting with the American Welding Society, "Welding in National Defense" was discussed by Col. G. F. Jenks, of the Ordnance Department of the U.S. Army, who illustrated his talk

with slides of various types of armament now being manufactured for the army. He pointed out that welding has improved the design and materially cut down the weight of the different implements of war. He also explained how the welds were tested. Then S. J. Callahan, structural engineer for Smith, Hinchman and Grylls, Inc., of Detroit, Mich., on the construction of the ammunition plant at Lake City, Mo., spoke on "The Engineer's Part at Lake City." Mr. Callahan stressed the fact that engineers are in great demand at the plant, their services being required by the architect-engineer, the contractor, the constructing quartermaster, the ordnance department, and the Remington Arms Company, which will operate the plant. Members of the Student Chapter at the University of Kansas were guests of the Section, and Ned Ashton, president of the Chapter, was presented with a pin by the American Welding Society as a memento of his outstanding work in behalf of the Chapter.

Maryland Section

A "Post-Convention Rally" was enjoyed by members and guests of the Maryland Section on May 22. Cocktails were served in a room decorated with photographs and other souvenirs of the Spring Meeting, at which the Section was host earlier in the season. Following a dinner President Fowler and Secretary Seabury spoke, as did Past-President Donald H. Sawyer, who has since died. Other speakers were Prof. A. G. Christie and Warren H. McBryde, former presidents of the American Society of Mechanical Engineers. Later there were colored motion pictures of the meeting, and the chairmen of the various committees that had worked on the Spring Meeting spoke briefly on matters relating to the successful functioning of their groups.

Nebraska Section

A "Ladies Night" program was presented in Lincoln on June 25. Entertainment included the showing of two sound films. The first, furnished by the U.S. Bureau of Reclamation, portrayed interesting features in connection with power development on the Columbia River; the second, loaned by E. I. du Pont de Nemours and Company, was the story of the manufacture of synthetic fabrics such as nylon.

Panama Section

Recent meetings of the Panama Section have been enhanced by the presence of various well-known engineers who are visiting Panama as consultants on the Canal Zone improvements. The June meeting, for instance, was addressed by Ole Singstad, chief engineer of the New York City Tunnel Authority, who discussed methods of tunnel construction. Other recent speakers were L. F. Harza, president of the Harza Engineering Company, who described the Santee-Cooper Project, and Arthur Casagrande, professor of civil engineering at Harvard University, whose subject was "Practical Aspects of Soil Mechanics." A detailed symposium on the preliminary design studies for the Third Locks Project is also in the process of presentation.

Philadelphia Section

The annual outing of the Section was held at the Sandy Run Country Club on June 10. The afternoon was given over to golf, soft ball, and quoits, prizes being awarded later to the winners. In the evening there was a dinner followed by the annual election of officers, which resulted in the choice of Charles A. Howland for president, and Lester L. Lessig for vice-president. E. L. Shoemaker will continue as secretary-treasurer, with James H. Allen to assist him. President Howland discussed the present emergency and suggested that the activities of the Section during the coming year be adjusted to the requirements of this emergency. The meeting was then thrown open to a discussion of Society affairs.

San Diego Section

Various phases of the defense program were discussed at the last three meetings of the San Diego Section. The construction of additional buildings for the Consolidated Aircraft Corporation, covering an area of fifty-three acres, was described by Herbert Moore at the April meeting. The bearing foundation consists of 70-ft steel pilings driven in groups at regular intervals and then capped with reinforced concrete. The "Testing of Materials in a Defense Program" was described at the May meeting by P. D. Helsley, of the Smith-Emory Testing Laboratory, San Diego. In June members of the Section were guests of the McNeil Construction Company for an inspection tour of the San Diego Housing Project. The project consists of 3,000 units, now under construction at a cost per unit of $3,000, which includes water and sewer mains, sidewalk, curb, grading, and paving. The first visit was to the chart room, where a large map showed the location of each unit and the amount completed to date. There are some fourteen different steps required in the construction of each unit from the laying of the foundation to the placing of the house number, and each step in the process is charted daily. Finally the group visited the prefabrication yards, where the framework of the house is assembled.

San Francisco Section

At a meeting held on June 17 John F. Parsons, senior aeronautical engineer for the Ames Aeronautical Laboratory at Moffett Field, California, presented a paper entitled "Research Facilities of the National Committee for Aeronautics." His talk was illustrated with motion pictures. Then J. H. Brunnier, structural engineer of San Francisco, showed pictures of and described the structural damage caused by the recent earthquake in Mexico City.

On May 26 the Junior Forum held its regular meeting, which featured a symposium on "Opportunities for Young Civil Engineers." Those taking part were Charles M. Duke, Alfred A. Finnila, and Otto W. Schrader, all Juniors. The subject for open discussion was "To What Extent Should the United States Aid Great Britain?"

Tacoma Section

On June 10 the Section heard J. Frank Ward, manager of the Division of Planning and Marketing of the Bonneville Administration, give an illustrated talk on the construction of the transmission lines connecting Bonneville and Grand Coulee dams, the Bonneville-Vancouver line, and the Bonneville-Willamette line. Mr. Ward also showed a moving picture of the two great dams in the process of construction and pointed out the public benefits derived from the projects.

Tennessee Valley Section

A musical program was presented during a dinner held on June 10. Later in the evening W. E. Barker, regional highway engineer for the Portland Cement Association, spoke on "Defense Highways." Mr. Barker outlined briefly the specifications for such highways and then showed two sound movies—entitled "Limited Ways" and "Pennsylvania Turnpike"—which showed construction and completed views of the type of highway adaptable to heavy traffic and defense uses.

Texas Section

The Dallas Branch of the Texas Section reports several interesting meetings in recent months. In June W. H. Klapproth, traffic engineer for the City of Dallas, discussed the traffic problems of large cities, illustrating his remarks with a movie of highways in and around New York. Grayson Gill then reported on the spring meeting of the Section. In July E. A. Wood, city plan engineer and park engineer for Dallas, described the new city market. Supplementary talks were given by Cole Stephen, city budget director, who discussed the financial set-up of the market, and R. E. McVey, who spoke on the "human side" of the project.

Toledo Section

On May 7 there was a special meeting for the purpose of awarding prizes for the best Junior and student papers on the ethics of a Junior construction engineer. The Section sponsored these awards for the first time this year. The Junior prize of $25 went to Don P. Reynolds, and a similar student award to Lamont Cadmus, of the University of Toledo. Both authors read their respective papers, after which William Housel, associate professor of civil engineering at the University of Michigan, spoke on soil mechanics.

Wisconsin Section

The fact that engineers have a keen interest in proper municipal planning was demonstrated at a joint session with the Engineers' Society of Milwaukee, held on June 18. The program consisted of a talk on the city's planning problems, given by Charles B. Bennett, city planning engineer of Milwaukee, whose remarks stimulated an especially spirited discussion.

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for September

Outstanding in many respects, the Pit River Bridge presents unique construction problems. Built in mountainous terrain, this combined railway and highway structure has unusually deep footings, tall piers, and heavy reinforcing. All these possibilities combined in one bridge are described in the paper by the late Roy M. Snell, senior engineer in charge of railroad construction on the Central Valley Project in California.

On another outstanding project Willard J. Turnbull tells of the steep slopes used in loess soil during the construction of the Tri-County Project in central Nebraska. Large economies were effected on this work by taking advantage of the peculiar nature of the soil. Laboratory analysis combined with observed natural banks suggested the use of steep slopes along 75 miles of canal, thus making large savings possible in the cuts as originally anticipated.

Also scheduled for September is a study of stresses due to the impact of landing planes on vitrified clay pipes embedded below landing fields and runways. When one considers that the Douglas B-19 Super Bomber, weighing 80,000 lb, touches the runway at a speed in excess of 75 miles an hour, one can judge the nature of the landing impact.

Among other papers is one by William J. Eney, "Analysis of Continuous Girders with Celluloid Models and Special Gages," in which Professor Eney describes special apparatus designed for a unique girder analysis.

The C. E. Schwob article on "Details of Design Affecting Treatment Plant Operation," originally scheduled for August but held over because of last-minute revisions, will also be in the September issue along with a variety of papers from the San Diego Convention.

TVA Publishes New Technical Reports

Two new volumes in the series of Technical Reports on projects completed by the Tennessee Valley Authority have been issued by that organization and given to the Engineering Societies Library.

Technical Report No. 3—on "The Pickwick Landing Project"—covers the general program of the unified development of the Tennessee River system and describes the part the Pickwick Landing Project plays in this development. Preliminary project investigations, design, methods of construction, access roads, and employee housing are some of the many subjects discussed in this 431-page volume. Cloth-bound copies of the report may be procured from the Superintendent of Documents, Washington, D.C., at $1 each.

A similar study of the Guntersville Project constitutes Technical Report No. 4. This volume, which is entitled "The Guntersville Project," contains 423 pages and 113 illustrations. Cloth-bound copies are for sale at $1 each in the Treasurer's Office, Knoxville, Tenn.

Welders' Jargon

"Jitterbugs" and "jive cats" are not the only people these days to use a colorful jargon unintelligible to the uninitiated. Welders, too, have a lingo all their own. In fact a "Welders' Dictionary" has been compiled by Charles H. Jennings, Westinghouse welding expert. Among the picturesque slang terms he lists as used in welding shops the country over are the following:

diggin-in—Act of obtaining deep penetration.

dingle balls or doodle berries—Molten particles of spatter falling from the electrode when welding in the vertical and overhead positions.

fish-eye or snake-eye—Characteristic marking sometimes found on the fractured surface of a tensile specimen consisting of a central flaw surrounded by a bright circular area; surface of flaw is slightly concave and disposed approximately at right angles to the direction of applied stress.

grapes—Elongated particles of weld metal hanging from the surface of an overhead weld.

icicles—Localized raised sections on the reverse side of a welded joint formed by drops of molten metal becoming solidified during the process of falling from the joint.

jazz-box—Small size a-c welding transformer

kick—Electric shock.

skip—Discontinuity in a weld.

snappy arc—An electric arc which makes sharp crackling sounds.

stumbling—Act of unintentionally interrupting the welding arc as a result of improper electrode manipulation, welding technique, or conditions.

volcano—Eruption occurring after the first layer on a multiple layer weld which is accompanied by an explosion and a shower of molten metal, caused by the explosion of gas inclusions in the under layers.

welder's floss or welder's silk—Coagulated iron-oxide particles which float in the air. Obtained when welding with bare type electrodes.

welder's pliers—Electrode holder.

worm holes—Elongated gas holes sometimes obtained in deposited weld metal.

Prof. N. G. Neare's Column

Conducted by

R. Robinson Rowe, M. Am. Soc. C.E.

The minutes of the August meeting of the Engineers Club showed that our Secretary read, inter alia, the following communication:

Gentlemen Engineers:

Even tho I am attending our Annual Convention and visiting my old home in San Diego, there is no rest for the rest of you; for this letter will dispose of Al E. Dayde's survey and leave you with a fresh assignment.

Many of you located the symmetrical tract astride the equator, computing an area of 640.000003 acres, overlooking the fact that the Government has no color of title to equatorial lands.

Two shrewd first-nighters, Cuyler W. Lush and David E. Hughes, said the tract was on a hill sloping toward the equator. This is a possibility that I had overlooked, or I would have written the problem to exclude it. But the Manual does not specify that measured distances be reduced to sea-level arcs, so full credit is due these gentlemen at my expense. Lush noted that the area would depend upon the latitude; Hughes computed an area of 639.94 acres for his home latitude and observed that the hill would slope at $1^1/_2$:1 in Lat 33°41′, being on a cylinder about the earth's axis.

Four of you offered the ingenious solution shown in Fig. 1 attached, but Al would certainly have described this as two tracts; besides the intersecing north-south lines are hardly "opposite."

Only three of the most persistent (in order, Richard Jenney, Henry Kuphal, and F. W. Robison) finally located the tract, Fig. 2, which Jenney named "Keyhole

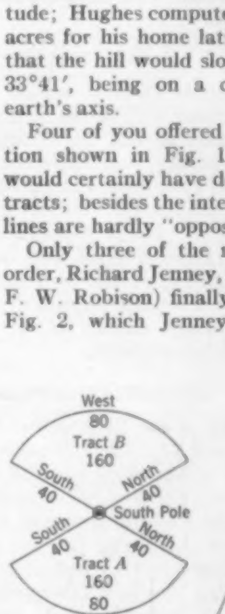


Fig. 1

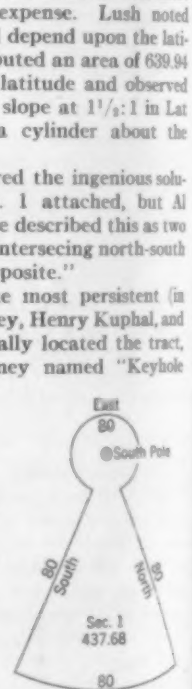


Fig. 2

National Park." Each found an area of 437.68 acres [$320(a + \sqrt{1 + a^2})$, where a is the reciprocal of π]. We may describe it simply as Sec 1, T 1 N, R 1 E, Byrd B.M.

Now for an easier task, which may tease our Estimators. Working overtime on an airport water distribution system, S. T. Mayter ran into a fiscal snag. He needed a quotation on a lot of 4,000 ft of 4-in.

pipe, 5,000 ft of 5-in., and 6,000 ft. of 6-in., but all pipe salesmen had left town for the week end.

Then he remembered that he had made two purchases since prices had been frozen. He had paid $970 for 1,000 ft of 6-in., 3,000 ft of 5-in., and 5,000 ft of 4-in. pipe on one project and $1,350 for 1,000 ft of 4-in., 4,000 ft of 5-in., and 7,000 ft of 6-in. pipe on the other. He also remembered that unit prices did not involve fractions of a cent. This gave him more than enuf data to compute the price for one foot of each kind of pipe and the proper quotation for the lot required at the airport. I recommend the calculation as an interesting exercise.

Greetings to all of you from San Diego. I'll be with you in September to discuss that Hollywood bathroom, which I inspected en route.

Sincerely yours,
NOAH G. NEARE

Members Awarded Honorary Degrees

DURING the commencement season each year honorary degrees are awarded certain engineers who have made distinguished contributions to the profession. Word of several members of the Society thus honored has been received at Society Headquarters, and the list of these follows. Perhaps there are others of whom the Society has not heard.

O. H. AMMANN, Doctor of Science, Columbia University.

GEORGE W. BOOTH, Doctor of Engineering, Worcester Polytechnic Institute.

KARL R. KENNISON, Doctor of Science, Colby College.

Forty-Ninth Annual Meeting of S.P.E.E.

THE importance of engineering education in national defense was stressed by the speakers addressing the 49th annual meeting of the Society for the Promotion of Engineering Education, which took place in Ann Arbor, Mich., June 23–27. Over a thousand engineers and educators attended the various events, which included a separate conference for civil engineers as well as four general sessions. The civil engineers' conference was under the direction of L. G. Straub, professor of hydraulics at the University of Minnesota, and E. E. Bauer, assistant professor of civil engineering at the University of Illinois.

The general sessions included discussion of engineering defense training, engineering curricula, industrial relations, and student selection and guidance. It was stated that the greatest gain in the S.P.E.E. program is in the better understanding of the problems of industry. It was also brought out that, since the E.C.P.D. believes that no college credit should be given for engineering defense training courses, universities and colleges offering such work would be advised that no modifications of their programs should be made in order to adapt their work for college credit.

A comprehensive report on the meeting was submitted by Prof. R. B. Wiley, the Society's delegate.

Daniel W. Mead Honored at Hydrology Conference

AT the recent conference on hydrology, held at Pennsylvania State College from June 20 to July 2, Daniel W. Mead, Past-President and Honorary Member of the Society, was presented with a scroll in recognition of his distinguished work in the field of hydrology and hydraulic engineering as a practicing civil engineer and teacher. Dr. Mead's *Notes on Hydrology*, published in 1904, was the first American book on the subject.

Engineers from 31 states and the Canal Zone were present at the conference, which was the first of its kind to be held. The program for this highly successful affair included five major symposia—on the scope of applied hydrology, rainfall and runoff, delays in the hydrologic cycle, losses in the hydrologic cycle, and flood problems—and round-table discussions.

Sponsoring groups were the section of hydrology of the American Geophysical Union, the civil engineering division of the Society for the Promotion of Engineering Education, the Committee on Hydrology of the American Society of Civil Engineers, and Pennsylvania State College.

New Civil Service Examination

AN examination for inspectors of hulls and boilers in the Bureau of Marine Inspection and Navigation has been announced by the U.S. Civil Service Commission. There are a large number of these positions, with salaries of $3,200 a year. Applicants must have had experience on U.S. merchant vessels while holding a U.S. license.

The written test for assistant inspector of hulls will comprise technical and practical questions relating to the construction, inspection, and strength of wood and steel hulls. Applicants for assistant inspector of boilers will be given technical and practical questions relating to the construction, operation, and inspection of the machinery and equipment of vessels.

The maximum age limit is 48. Applications will be rated as received in the Washington office of the Commission until September 4, 1941.

NEWS OF ENGINEERS

Personal Items About Society Members

THOMAS M. NILES, who has been on the staff of the consulting firm of Greeley and Hansen, Chicago, Ill., has been made a partner in the firm.

WILLIAM R. WALLIS recently resigned from Allied Engineers and Taylor and Taylor, architects and engineers (both Los Angeles firms), in order to accept an appointment as associate structural engineer with the U.S. Engineer Department at Los Angeles.

ANSON MARSTON, Past-President and Honorary Member of the Society, was awarded the Lamme Medal on June 26. The award is given annually by the Society for the Promotion of Engineering Education to a technical teacher chosen for his accomplishment in technical teaching or for actual advancement in the art of technical training. Dean Marston was pro-

ANSON MARSTON

fessor of civil engineering at Iowa State College from 1892 to 1920, and dean of engineering from 1904 to 1932. He is now dean emeritus. Additional Lamme medals are awarded each year by the American Institute of Electrical Engineers and Ohio State University.

JOSEPH WARREN BARKER, dean of the Columbia University engineering school, has been appointed special assistant to Assistant Secretary of the Navy Lewis Compton, for whom he will serve as Chief of the Division of Training Liaison and Coordination. During his absence JAMES K. FINCH, Renwick Professor of Civil Engineering, will be acting dean.

J. C. RATHBUN has been promoted from the position of associate professor of civil engineering at the College of the City of New York to the rank of full professor, the promotion to be effective on January 1, 1942. Dr. Rathbun joined the City College faculty in 1931.

W. W. HORNER announces his resignation as professor of municipal and sanitary engineering at Washington University (St. Louis, Mo.) in order to devote himself primarily to his consulting practice. He is a member of the firm, Horner and Shifrin, with offices in the International Office Building, St. Louis.

S. S. STEINBERG, dean of the college of engineering at the University of Maryland, has been appointed a member of the Maryland State Board of Registration for Professional Engineers and Land Surveyors for a five-year term.

FRANKLIN D. HOWELL is now president of Associated Consultants, Inc., a company recently organized for the purpose of acting in the capacity of agent, trustee, or adviser, in the maintenance and operation of any kind of property. The offices of the organization are in the Pacific Electric Building, Los Angeles, Calif.

LYLE E. SEEMAN, major, Corps of Engineers, U.S. Army, was recently transferred from the 94th Engineer Battalion at Fort Custer, Mich., to the Engineer Board at Fort Belvoir, Va.

CECIL E. PEARCE has accepted a position as head civil and hydraulic design engineer in the Department of Public Utilities of the City of Tacoma, Wash., on the second Nisqually Power Development. Until lately Mr. Pearce was principal engineer for the U.S. Corps of Engineers at Denison, Tex.

BAXTER L. BROWN, formerly president of the Board of Public Service of the City of St. Louis (Mo.), announces that he has resumed practice as a consulting engineer at 1204 Landreth Building, St. Louis.

J. C. BISSET recently resigned as city engineer of Corpus Christi, Tex., in order to accept the position of assistant director of public works for the City of Dallas, Tex.

VERNE GONGWER is chief engineer of construction for the Department of Public Utilities of the City of Tacoma on the second Nisqually Power Development.

C. N. JOYNER, formerly with T. L. James and Company, of Ruston, La., is now a senior business specialist with the Production Division, Office of Production Management, Washington, D.C.

CHARLES H. ELLABY has resigned as senior engineer in the U.S. Engineer Department at St. Louis, Mo., in order to accept an appointment as president of the Board of Public Service of St. Louis.

HENRY J. BRUNNIER, consulting structural engineer of San Francisco, is the 1941 recipient of the Marston Medal, which is awarded annually to an engineering alumnus of Iowa State College in recognition of engineering achievement. The award was established by Iowa State College through the generosity of Anson Marston. Mr. Brunnier has maintained his consulting practice in San Francisco since 1908, his work including many important Pacific Coast projects.

ELMER K. TIMBY has taken a year's leave of absence from his duties as associate professor of civil engineering at Princeton University and will be associated with Howard, Needles, Tammen and Bergendoff, consulting engineers of New York and Kansas City.

CLAUDE H. RICE recently became connected with the Fidelity and Casualty Company, of New York City.

REGINALD MOLSTAD, formerly project engineer for the PWA in New York City, is now in the Washington, D.C., office of the organization, where he holds the position of engineer.

JOHNSON L. FORBIS is now with the Stone and Webster Engineering Corporation, which he is serving as structural inspector on the construction of the Venice No. 2 Power Plant for the Union Electric Company of Illinois. Until recently he was district director of operations for District 4 of the WPA at Tulsa, Okla.

C. R. YOUNG, professor of civil engineering at the University of Toronto, has been appointed dean of the Faculty of Applied Science and Engineering at the University, succeeding BRIG. GEN. CHARLES H. MITCHELL, who has retired.

FRED L. MOORE has been promoted from the position of staff engineer for the Quality Bakers of America, with headquarters in New York, to that of director of engineering for the same organization. He has also been commissioned a major in the New York Guard and assigned as engineer officer to the Second Brigade Headquarters of the New York Guard.

HOWARD M. HAYES is now with Ford, Bacon, and Davis as chief civil engineer of the Eastern Division of the Baton Rouge-Greensboro Plantation Pipe Line Contract, with headquarters at Greenville, S.C. He was previously party chief for the Harza Engineering Company at Moncks Corner, S.C.

JAMES E. CZEL, JR., until lately junior engineer for the Federal Power Commission, Washington, D.C., has accepted an appointment as assistant engineer in the U.S. Engineer Office at Norfolk, Va., where he will be engaged in power studies on proposed dams within the district.

ERIK JOSEPH ERIKSSON has accepted a position as construction engineer at the Gary works of the Carnegie-Illinois Steel Corporation. During the past two years Mr. Eriksson has served as assistant city engineer for the city of Duluth, Minn.

JOSEPH GUY ROLLINS, division engineer for the Texas State Highway Department, has been appointed director of public works for the city of Dallas, Tex.

GEORGE W. CASE, dean of the college of technology at the University of New Hampshire, has been granted a leave of absence to go to Washington, where he will assist in organizing the training of engineers and skilled workmen for defense industries.

ALFRED M. LUND, president of the Lund-Buxton Engineering Company, of Little Rock, Ark., was recently appointed area manager of the Defense Contract Service of the Office of Production Management.

THEODORE S. JOHNSON, since 1933 professor of sanitary engineering at North Carolina State College, has been appointed full-time secretary and coordinator of the North Carolina State Defense Council.

JOHN M. SALMON, formerly assistant supervisor of bridges and buildings for the Louisville and Nashville Railroad, is now assistant division engineer, with offices at Middlesboro, Ky.

WILLIAM C. E. BECKER has resigned as chief engineer of bridges and buildings for the City of St. Louis in order to return to the private practice of engineering. He will have offices in the Ambassador Building, St. Louis.

F. HERBERT SNOW has been named consulting engineer for the city of Harrisburg, Pa. Until recently he was secretary of the Pennsylvania Water Works Association.

M. L. SHADBURN is now chief engineer of the Georgia State Highway Department, with headquarters at Atlanta.

DECEASED

JOHN ALBERT DALEN (M. '38) consulting structural engineer of New York City, died on February 18, 1941. Mr. Dalen, a native of England, was 57. Before establishing his own practice in 1927, he had been with the Public Service Commission of New York City (1914 to 1916); the E. F. Terry Manufacturing Company (1918 to 1920); and S. C. Weiskopf, New York City consultant (1920 to 1924). He designed many notable New York buildings.

WALTER JULES DOUGLAS (M. '07) consulting engineer of New York City, died there on July 2, 1941, at the age of 68. From 1900 to 1910 Mr. Douglas was engineer of bridges for the District of Columbia, and later was chief engineer on the construction of the Cape Cod Canal and maintenance engineer of the Panama Canal. For many years he was associated with the late William Barclay Parsons, the firm later becoming Parsons, Klapp, Brinckerhoff, and Douglas. Notable projects designed and constructed by Mr. Douglas include the Detroit-Windsor vehicular tunnel and a similar tunnel under the Scheldt River at Antwerp, Belgium.

BENJAMIN ALEXANDER HODGDON (M. '19) retired engineer of White Plains, N.Y., died on April 6, 1941, at the age of 66. From 1912 until his retirement in 1938 Mr. Hodgdon was with the New York City Board of Transportation, which he served as section engineer, assistant engineer, and resident engineer on the construction of the city's subway system.

PHILIP HOLDEN GLOVER (Assoc. M. '12) city engineer of Bangor, Me., from 1932 until illness forced his retirement a few months ago, died at his home at Harrington, Me., on May 30, 1941. He was 58. Earlier in his career Mr. Glover was with the U.S. Bureau of Reclamation, the Bangor and Aroostook Railroad, and the International Paper Company in Santo Domingo. He had also been resident bridge engineer for the Bangor District of the Maine State Highway Commission.

EDWARD ADOLPH HERMANN (M. '87) president of the Reliance Whiting Company, Alton, Ill., died in St. Louis, Mo., on June 11, 1941. Mr. Hermann, who was 84, began his engineering career in 1879. For fifteen years he was in railroad work—with the Pennsylvania and Big Four Railroads—and for ten years in municipal work for the city of St. Louis. He then engaged in the manufacture of whiting, starting on a small scale and soon developing the undertaking into a large business.

JOHN MIFFLIN HOOD, JR. (M. '10) of Los Angeles, Calif., died suddenly in Lawrenceville, N.J., on June 16, 1941. Mr. Hood, who was 61, was stricken while en route to New York from Princeton University, where he had been attending his class reunion. In 1923 Mr. Hood retired as president of the Crown Cork and Seal Company, of Baltimore, after being with the organization sixteen years. Earlier in

his career he had served in the engineering departments of several railroads, including the Pennsylvania and the Baltimore and Ohio. He had also been chief engineer of the United Railway and Electric Company.

James Wesley Kievit (Assoc. M. '39) who was in the sales department of the Owens-Illinois Glass Company, Toledo, Ohio, was killed in an automobile accident near Irwin, Pa., on May 29, 1941. He was 34. Before joining the Owens-Illinois Company in 1936, Mr. Kievit was structural engineer for the H. P. Jones Company, of Toledo, and earlier had held a similar position with the Froehlich and Emery Engineering Company, of Toledo.

Stuart Kelsey Knox (M. '13) consulting hydraulic and sanitary engineer of New York, N.Y., died in Montclair, N.J., on June 28, 1941, at the age of 62. Mr. Knox was with the Thompson-Starrett Company from 1904 to 1907, and with Nicholas S. Hill, Jr., of New York City, from 1908 to 1934—part of the time as member of the firm and co-partner. In the latter year he established his own practice. During the World War Mr. Knox served as engineer in charge of design and construction for the U.S. Housing Bureau.

Otto V. Kruse (M. '24) general sales manager of the Baldwin Locomotive Works, Philadelphia, Pa., died at his home near there on July 1, 1941. Mr. Kruse, who was 54, had been associated with the Larner Engineering Company and, also, had been consulting engineer for the William Cramp and Sons Ship and Engine Building Company. He became connected with the Baldwin Locomotive Works in 1931.

Harry Alfred Lane (M. '10) chief engineer for the Baltimore and Ohio Railroad, died in Baltimore, Md., on June 21, 1914, at the age of 66. Mr. Lane began his railroad engineering career in 1895 as a rodman with the New York, New Haven and Hartford Railroad. In 1902 he transferred to the Baltimore and Ohio, where he served in various capacities, becoming chief engineer in 1917.

Elmer James McCaustland (M. '05) of Albuquerque, N.Mex., died there on May 16, 1941. Mr. McCaustland, who was 77, was dean of the faculty of engineering and professor of sanitary engineering at the University of Missouri from 1914 until his retirement in 1935. Earlier in his career (1903 to 1907) he was assistant professor of civil engineering at Cornell University, and he had also taught at the University of Alabama and the University of Washington.

Bernard John O'Rourke (Assoc. M. '16) engineer and contractor of Norristown, Pa., died on June 13, 1941. He was about 55. Before establishing his engineering and contracting partnership with his brothers, Mr. O'Rourke was for some years superintendent of construction for the Dale Engineering Company at Utica, N.Y.

Robert Louis Shape (M. '27) New York City architect, died on June 16, 1941, at the age of 69. After serving in the Spanish-American War Mr. Shape became an architect. From 1913 until the World War—when he was engaged in shipbuilding for the government on the Pacific Coast—he was a partner in the firm of Shape, Bready and Peterkin. After the war he joined the firm of Hart and Shape, which was responsible for the design of many notable New York buildings. For the past four years Mr. Shape had been in Washington on housing projects for the Resettlement Administration and as senior engineer for the PWA.

John Joseph Henry Sharon (Assoc. M. '13) secretary of the Public Utilities Commission of San Francisco, died on May 18, 1941, at the age of 62. From 1897 until 1936 Mr. Sharon was with the Spring Valley Water Company—as assistant, assistant to the chief engineer, assistant superintendent of operation and maintenance, assistant engineer, and assistant manager.

Grier Ralston Smiley (Assoc. M. '08) chief engineer of the Louisville and Nashville Railroad, Louisville, Ky., died at Miami Beach, Fla., on June 11, 1941. He was 61. Joining the railroad twenty-eight years ago as a resident engineer, Mr. Smiley became chief engineer in charge of construction in 1920, was promoted to the position of assistant chief engineer in 1931, and two years later was made chief engineer.

Roy Martin Snell (M. '22) senior engineer for the U.S. Bureau of Reclamation at Redding, Calif., died on June 29, 1941. Mr. Snell, who was 60, was with the Bureau of Reclamation from 1906 to 1915, from 1917 to 1924, and again from 1935 until his death. He was engaged on the Shasta Project for the Bureau at the time of his death. From 1924 to 1934 he was resident engineer on dam construction for the government of Puerto Rico.

Harold Ulmer Wallace (M. '04) consulting engineer of Savannah, Ga., died at his home at Elberton, Ga., on June 22, 1941, at the age of 69. Mr. Wallace had been chief engineer for the Illinois Central Railroad and general manager of the Western Light and Power Company and of the Detroit Municipal Railway. More recently he was in charge of the WPA at Savannah. He held a commission as lieutenant colonel in the U.S. Reserve Corps of the army.

George Edward Willcomb (Assoc. M. '12) technical supervisor of the Albany (N.Y.) water and sewage purification plant died at Menands, N.Y., on June 1, 1941. Mr. Willcomb, who was 61, had been chemist in charge of the Albany Filtration Works and supervising chemist of the Albany Water and Sewage Treatment Works. He had also maintained a private practice in Albany.

Walter Scott Winn (M. '26) of Bristol, Tenn., was killed in an automobile accident on May 31, 1941, while touring in North Carolina. Mr. Winn, who was 72, retired in 1939 after some years in the U.S. Engineer Office. He had been senior engineer at Huntington, W.Va., and principal hydroelectric engineer in the District Office at Cincinnati. At one time, also, he was assistant to the chief engineer of the Alabama Power Company.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From June 10 to July 9, 1941, Inclusive

Additions to Membership

Abbott, John Alfred, Jr. (Jun. '41), Insp., Whitman, Requardt & Smith, Charles and Biddle, Baltimore (Res., 29 East Irvin Ave., Hagerstown), Md.

Archibald, George Edward (Assoc. M.'41), Civ. Engr., Ebasco Services, Inc., 2 Rector St., New York, N.Y.

Barrish, Jack Simon (Jun. '41), Asst. Engr. (Civ.), U.S. Engr. Office, 208 Post Office Bldg., Sacramento, Calif.

Bauer, John Victor (Assoc. M.'41), Instr., School of Technology, College of City of New York, 140th St. and Convent Ave., New York (Res., 110-32 Two Hundred and Eighth St., St. Albans), N.Y.

Beaver, John Ferris (Jun. '40), With Gen. Elec. Co., Philadelphia, Pa. (Res., 3816 Review Pl., New York, N.Y.)

Bevan, Roby Bedell (Assoc. M.'41), Associate Structural Engr., TVA, 313 Union Bldg. (Res., 1804 Chicago Ave.), Knoxville, Tenn.

Brown, Wallace Merton (Jun.' 41), Lt. (jg), CEC, U.S.N.R., Navy Bldg. (Res., 3905 Davis Pl., N.W., Apt. 101), Washington, D.C.

Campbell, Neal J. (M. '41), Cons. Engr., 911 Locust St., St. Louis, Mo.

Clark, Luther Daniel (Jun. '41), Asst. Constr. Supt., WPA, 3407 Lemmon, Dallas, Tex.

Clarke, Harold (Assoc. M. '41), Associate Engr., U.S. Engr. Office, Honolulu, Hawaii.

Cutler, Louis (Jun. '41), Draftsman, U.S. Engrs., Mitchel Field (Res., 469 Sheffield Ave., Brooklyn), N.Y.

Daly, William Joseph (Jun. '41), Junior Civ, Engr., Office of Quartermaster Gen. (Res., 1423 Clifton St., N.W.), Washington, D.C.

Davis, Hugh Joseph (Jun. '41), Instr., Civ. Eng., Southern Methodist Univ. (Res., 6618 Dickens Ave.), Dallas, Tex.

Day, Herbert Boris (Jun. '41), With Pan-Am. Airways, Airport Development Dept. (Res., 635 West Levee), Brownsville, Tex.

DeBerry, Bannister Luther (Jun. '41), Field Engr., State Highway Dept. (Res., 306 West Taylor St.), Clarksville, Tex.

Dillon, Robert Emmet (M. '41), Vice-Pres., Production and Eng., Boston Edison Co., 182 Tremont St., Boston, Mass.

DLYN, HARRY LOUIS (M. '41), Chf. Engr., Chanin Constr. Co., 122 East 42d St., New York, N.Y.

DOLLAR, HENRY (Jun. '41), Eng. Asst., Board of Water Supply, Lackawack, N.Y.

FORNEROD, MARCEL FRANCIS (Assoc. M.'41), Civ. Engr., M. W. Kellogg Co., 225 Broadway, New York (Res., 3 Chelsea Rd., Mayfair Acres, White Plains), N.Y.

GILLAN, GERALD KEITH (Jun. '41), Instr., Civ. Eng., Univ. of Missouri, Columbia, Mo.

GILLESPIE, ROBERT NEWTON (Assoc. M. '41), Engr., Cement Gun Co., Inc., Allentown, Pa.

GRAVES, HERSHEL DOUGLAS (M. '41), Associate Highway Bridge Engr., Public Roads Administration, Box 3900, Portland, Ore.

GRAYMAN, ROBERT (Jun. '41), Asst. Engr. (Structural), U.S. Engr. Office, Box 1234, Cincinnati, Ohio.

GUARNERA, SALVATORE (Jun. '41), 245th Coast Artillery, Battery 1, Fort Tilden, N.Y.

HALL, JOHN ATKINS (Jun. '41), Supt., Dixie Culvert Mfg. Co., 1601 East 9th, Little Rock, Ark.

HANCOCK, J. D. (Jun. '41), Junior Civ. Engr., SCS, U.S. Dept. of Agriculture, Rodeo, N.Mex.

HARNED, EDWARD JOHNSON (Jun. '41), Junior Engr., U.S. Engr. Office, 203 Calvert Bldg. (Res., 304 East University Parkway), Baltimore, Md.

HAYES, HARRY (Assoc. M. '41), San. Eng. Associate, Dept. of Water and Power, 207 South Broadway, Los Angeles, Calif.

HENSLEY, JAMES CARLISLE (Assoc. M. '41), (Childs & Hensley), 435 Pine St., Abilene (Res., 3721 Lenox Drive, Forth Worth), Tex.

HERRICK, DONALD FREDERICK (M. '41), City Supt., City Hall, Charlevoix, Mich.

HOWLAND, ARTHUR EASTMAN (M. '41), Structural Engr., 616 North Avenue 66, Los Angeles, Calif.

HURTLEY, WALTER ALEXANDER (Jun. '41), Flying Cadet, Air Corps, U.S. Army, Chanute Field, Ill.

JARRELL, MILTON (Assoc. M. '41), Chf. Bridge Draftsman, B. & O. R.R., B. & O. Bldg. (Res., 3815 Ridgewood Ave.), Baltimore, Md.

KARP, WILLIAM BUBBLES (Jun. '41), Junior Engr., Dist. Engrs., Wright Field, Dayton, Ohio.

KETCHEN, LAWRENCE LINDBERG (Jun. '41), Junior Structural Engr., U.S. Navy, Naval Air Station, Quonset Point (Res., 121 Chapmans Ave., Greenwood), R.I.

KRYSHAK, JOSEPH STANISLAUS (Jun. '41), Junior Engr. (Structural), TVA, Arnstein Bldg. (Res., 1205 Sevier Ave.), Knoxville, Tenn.

LEA, WILLIAM CHESTER (Assoc. M. '41), Mgr., Charleston Office, B. P. McDonough, Parkersburg (Res., 3909 McCorkle Ave., Charleston), W.Va.

LETTS, JAMES OTIS (Assoc. M. '41), Associate Engr., U.S. Engr. Dept., Rock Island, Ill.

LEVY, STANLEY EDWIN (Jun. '41), Junior Structural Engr., TVA, Watts Bar Dam, Tenn.

McCLURG, VERNE ORVA (M. '41), Chf. Structural Engr., Holabird & Root, 333 North Michigan Ave., Chicago, Ill.

MEAD, LAWRENCE MYERS, JR. (Jun. '41), 537 East Front St., Plainfield, N.J.

MILLER, EDWIN CHARLES (M'41), Vice-Pres., Drainage Contrs., Inc., 14375 Schaefer Highway, Detroit, Mich.

NAGEL, ROBERT HAMILTON (Jun. '41), Junior Office Engr., TVA, Union Bldg. (Res., 1718 White Ave.), Knoxville, Tenn.

NEELY, ELMER ALLEN (Jun. '41), 1st Lt., Coast Artillery, U.S. Army Battery L, 4th Coast Artillery, Fort Amador, Canal Zone.

NIVEN, FRANCIS JOSEPH (M. '41), 2306 Crawford, Houston, Tex.

ORRIN, ROBERT CARLTON (Jun. '41), Asst. Eng. Aide, TVA, Fort Loudoun Dam (Res., 203 A St.), Lenoir City, Tenn.

OVIATT, EUGENE EDWARD (M. '41), Chf. Engr., N.Y., N.H. & H. R.R., 71 Meadow St., New Haven (Res., 72 Pickwick Rd., Hamden), Conn.

PARKER, ALBERT DENNY (Assoc. M. '41), Engr., Kaiser Co., Mare Island, Vallejo (Res., 2100 Virginia St., Berkeley), Calif.

PASTORIUS, JAMES WALLACE (Assoc. M. '41), Engr. in Chg., Constr., Whitehall Cement Mfg. Co., Cementon (Res., 608 Pine St., Catasauqua), Pa.

PICKERING, HAROLD PHILLIP (Assoc. M. '41), Drainage Products Engr., Republic Steel Corp., Republic Bldg., Cleveland (Res., 406 Oak Cliff Drive, Bay Village), Ohio.

PRATHER, JAMES CARTER (Assoc. M. '41), Asst. Gen. Supt., Rich's, Inc., 45 Broad St., S.W., Atlanta, Ga.

RITCHEY, FORREST (Jun. '41), Asst. Engr. (Civ.), U.S. Engr. Office, TAO, Army Post Office 803, Port of Spain, Trinidad.

ROBERTSON, CECIL WINSTON (Jun. '41), Job Engr., E. B. Badger & Sons Co., Ordnance Works, Baytown (Res., 609 North Gilliard St., Goose Creek), Tex.

SCHULTZ, SAMUEL (Jun. '41), Field Engr., Bethlehem Steel Co., Tynan and Webster, Alameda (Res., 1760 Walnut, Berkeley), Calif.

SPILIGOJ, GODFREY DESIDERIUS (Assoc. M. '41), 54 Stewart Ave., Stewart Manor, N.Y.

SHIRA, WILLIAM SPENCE (Jun. '41), With Allis-Chalmers Mfg. Co. (Res., 3022 West Pierce St.), Milwaukee, Wis.

SMITH, MILLARD ELTING (Assoc. M. '41), Prin. Eng. Aide, TVA (Res., 316 Head St.), Paris, Tenn.

SPARGO, GEORGE EDWARD (M. '41), Executive Officer, Dept. of Parks, Arsenal, Central Park, New York (Res., 71–40 Juno St., Forest Hills), N.Y.

STANLEY, ARTHUR EMMONS (Assoc. M. '41), (Stanley Eng. Co.), Central State Bank Bldg., Muscatine, Iowa.

STEINBORN, SYDNEY OSWALD (Jun. '41), Asst. Civ. Engr. (Hydr.), The Panama Canal, Diablo Heights, Canal Zone.

TEIXEIRA, STANLEY EDWIN (Jun. '41), Structural Draftsman, Henry J. Brunnier, Box 80, U.S. Submarine Base, Coco Solo, Canal Zone.

THOMAS, NATHAN O'BERRY (Jun. '41), Junior Hydr. Engr., U.S. Geological Survey, Box 2052, Jackson, Miss.

VALENTINE, WILLIAM JOSEPH (Assoc. M.'41), Asst. Development Engr., State Public Service Authority, 204 Peoples Bldg., Charleston, S.C.

WEDDING, PRESLEY ALLEN (Jun. '41), Eng. Draftsman, Berrall & Locroft, 615 Colorado Bldg. (Res., 1331 Gallatin St., N.W.), Washington, D.C.

WELLONS, CHARLES McCARTNEY (M. '41), Prin. Engr., U.S. Engr. Office, Chamber of Commerce Bldg., Pittsburgh, Pa.

YONKMAN, NICHOLAS FRED (M. '41), Asst. Dist. Engr., State Highway Dept., Cadillac, Mich.

MEMBERSHIP TRANSFERS

BRUMLEY, DAVID JOSEPH (Jun. '31; Assoc. M. '41), Engr., Utilities Div., U.S. Army Camp Quartermaster, Camp Shelby (Res., 1403 North Main St., Hattiesburg), Miss.

BUNKER, WILLIAM BEEHLER (Jun. '38; Assoc. M. '41), Capt., Corps of Engrs., U.S. Army, Officer in Chg., U.S. Hydrographic Office, Managua, D.N., Nicaragua.

COCHRAN, ALBERT LUDWELL (Jun. '36; Assoc. M. '41), Associate Engr. (Civ.), Office of Chf. of Engrs., 3262 War Dept. Bldg., Washington, D.C. (Res., 8306 Sixteenth St., N.W., Silver Spring, Md.)

COOPER, ANDREW JACKSON (Assoc. M. '30; M. '41), Mgr., Robert & Co., Inc., Box 1469, Jacksonville, Fla.

CORFITZEN, WILLIAM EDWARD (Jun. '32; Assoc. M. '41), Associate Engr., U.S. Bureau of Reclamation, Washington, D.C.

DODDS, ARTHUR EARNEST WILLIAM (Jun. '35; Assoc. M. '41), Associate Structural Engr., Bonneville Power Administration, 1300 North East Union Ave. (Res., 1515 North East Fremont St.), Portland, Ore.

TOTAL MEMBERSHIP AS OF JULY 9, 1941	
Members	5,730
Associate Members	6,684
Corporate Members	12,414
Honorary Members	33
Juniors	4,595
Affiliates	70
Fellows	1
Total	17,113

EISENLOHR, WILLIAM STEWART, JR. (Jun. '28; Assoc. M. '41), Associate Hydr. Engr., U.S. Geological Survey, North Interior Bldg., Washington, D.C. (Res., 626 North Jackson St., Arlington, Va.)

FLORA, WALTER WILSON (Jun. '34; Assoc. M. '41), Cons. Engr., 1618 Russell, Cheyenne, Wyo.

FOSTER, HERBERT BISMARCK, JR. (Jun. '32; Assoc. M. '41), Asst. San. Engr., Bureau of San. Eng., State Dept. of Public Health, 3093 Life Sciences Bldg. (Res., 479 Kentucky Ave.), Berkeley, Calif.

FRANCIS, GEORGE WALDEN (Assoc. M. '29; M. '41), Mgr. and Cons. Engr., The Francis Eng. Co., 303 Eddy Bldg., Saginaw, Mich.

GREEN, STERLING STEFFEN (Jun. '31; Assoc. M. '41), Materials Engr., Bureau of Water Works and Supply, 207 South Broadway (Res., 943 South Plymouth Blvd.), Los Angeles, Calif.

HENDON, HARRY HOLMAN (Jun. '32; Assoc. M. '34; M. '41), Chf. Engr., Jefferson County Court House (Res., 51 Norman Drive), Birmingham, Ala.

JOHNSON, LOYS ALMON (Jun. '37; Assoc. M. '41), Lt. (jg), CEC, U.S.N.R., Naval Air Station, Quonset Point, R.I.

KOEHM, EDWARD (Jun. '30; Assoc. M. '41), Engr., Dam Design, U.S. Engrs., War Dept., 751 South Figueroa (Res., 2612 Jeffries Ave.), Los Angeles, Calif.

LANDWEHR, WALDEMAR JOHN (Jun. '30; Assoc. M. '36; M. '41), Lt., CEC, U.S.N.R., Naval Air Station, Santurce, Puerto Rico (Res., 151 Kensington Drive, Madison, Wis.)

LOGAN, GLEN EARNEST (Jun. '31; Assoc. M. '41), Prin. Eng. Draftsman, U.S. Coast Guard, 430 Custom House, San Francisco (Res., Happy Valley Rd., Lafayette), Calif.

LORENZ, MERRILL CHARLES (Jun. '30; Assoc. M. '41), Associate Engr., U.S. Engr. Dept., Rock Island, Ill.

McARTHUR, THOMAS JOSEPH (Jun. '35; Assoc. M. '41), Asst. Engr., Grade 4, Board of Water Supply, City of New York, 127 Broadway (Res., 165 Grand St.), Newburgh, N.Y.

MAERKER, ERWIN (Jun. '16; M. '41), Civ. and Hydr. Engr., P. F. Loftus, 632 Oliver Bldg. (Res., 224 Arden Rd., Mount Lebanon), Pittsburgh, Pa.

MESSER, ROY THOMAS (Jun. '30; Assoc. M. '41), Asst. Traffic Engr., State Highway Comm. (Res., 1239 Orchard Drive), Ames, Iowa.

OSBORN, JOHN RICHARD (Jun. '38; Assoc. M. '41), Instr., Civ. Eng., Agri. and Mech. College of Texas, College Station, Tex.

PAPPIN, GORDON FRANCIS (Jun. '35; Assoc. M. '41), Quantity Survey Engr., Siems Drake Puget Sound, 2929 Sixteenth Ave., S.W. (Res., 4508 Glen Way), Seattle, Wash.

QUIRK, EDWARD PETER (Assoc. M. '24; M. '41), Associate Valuation Engr., State Public Service Comm., 80 Center St., New York (Res., 89–72 Two Hundred and Sixteenth St., Queens Village), N.Y.

SMITH, CARNEAL KIRBY (Jun. '34; Assoc. M. '41), Associate Civ. Engr., The Panama Canal, Box 920, Balboa, Canal Zone.

SMITH, LEWIS GORDY (Jun. '32; Assoc. M. '41), Asst. Engr., Dept. of Interior, U.S. Bureau of Reclamation, 406 Custom House, Denver, Colo.

TIPTON, ROYCE JAY (Assoc. M. '22; M. '41), Cons. Engr., 1231 First National Bank Bldg. (Res., 6005 East 17th Ave.), Denver, Colo.

TOWNSEND, GEORGE ELLSWORTH (Jun. '30; Assoc. M. '41), Asst. Hydr. Engr., TVA, 311 Union Bldg., Knoxville (Res., 620 Fair Ave., Fountain City), Tenn.

ZEIGLER, CHARLES FORREST (Assoc. M. '25; M. '41), Constr. Engr., Geiger & Rutherford, Box 206, Leavenworth, Kans.

REINSTATEMENTS

FLORENCE, ALEXANDER FREDERICK, Jun., reinstated June 11, 1941.

HORONJEFF, ROBERT, Jun., reinstated June 27, 1941.

LONEY, NEIL McINTYRE, M., reinstated July 7, 1941.

SAUNDERS, SANFORD WILLIAM, Assoc. M., reinstated June 16, 1941.

RESIGNATIONS

FREEMAN, ROBERT PORTER, Assoc. M., resigned June 19, 1941.

PORTER, ALAN ANDERSON, Assoc. M., resigned June 30, 1941.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

August 1, 1941 NUMBER 8

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

CAVENDISH, LYNN RAY (Assoc. M.), Charleston, W.Va. (Age 41) (Claims RCA 11.9 RCM 8.1) 1933 to date West Virginia State Road Comm., as Asst. Engr., as Dist. Constr. Engr. (Senior Engr.), and Dist. Engr.

CROSBY, LLOYD RUSSELL, Portland, Ore. (Age 52) (Claims RCA 12.0 RCM 20.0) 1934 to date Mgr. and Chf. Engr., Consolidated Timber Co.

FERGUSON, RANDON (Assoc. M.), Urbana, Ill. (Age 41) (Claims RCA 6.0 RCM 9.0) June 1924 to date Asst. Engr., Comm. on Stresses in Railroad Track Investigation.

GREEN, CARL EDWIN (Assoc. M.), Portland, Ore. (Age 35) (Claims RCM 12.9) Sept. 1928 to date State San. Engr., Oregon, being Director of Div. of San. Eng., etc.; also, at present Cons. Engr. of firm, John W. Cunningham & Associates.

HORNKOHL, FRED, Weldon Spring, Mo. (Age 47) (Claims RCA 10.8 RCM 7.8) Nov. 1940 to date Coordinator-Supt. of supply and distribution on a $24,000,000 TNT plant; March 1932 to Dec. 1935 and Nov. 1939 to Nov. 1940 on miscellaneous work; in the interim with PWA, Ft. Worth as Res. Engr. Inspector and Associate Engr.

HOUSE, HARRY MONO (Assoc. M.), DeRidder, La. (Age 47) (Claims RCA 7.0 RCM 17.6) Jan. 1941 to date with Benham Eng. Co., Leesville, La., as Coordinating Engr. on construction of Camp Polk; previously Contr.'s Eng., W. S. Bellows Constr. Co., Corpus Christi, Tex., on Naval Air Station; with Louisiana State Office of WPA.

HOWE, HARRY NORTHROP (Assoc. M.), Memphis, Tenn. (Age 59) (Claims RCA 7.0 RCM 23.0) Oct. 1907 to date member of firm, Gardner & Howe, Engrs.

KENAN, ROBERT LOVE, Montgomery, Ala. (Age 47) (Claims RCM 26.0) Sept. 1934 to date Cons. Engr., being owner of firm, R. L. Kenan & Associates.

LARSON, LEANDER (Assoc. M.), Kansas City, Mo. (Age 62) (Claims RCA 17.6 RCM 14.5) 1918 to date with U.S. Army as Capt., etc., at present Lt. Col.

LENDRKING, CARROLL MILTON, Tulsa, Okla. (Age 39) (Claims RCA 4.6 RCM 6.5) Sept. 1940 to date with Benham Eng. Co., as Asst. Roads and Drainage Engr., Camp Livingston, La., and since March 1941 Chf. Draftsman, Camp Polk, La.; previously with WPA, Tulsa, Okla., as Office Engr., Chf. Area Engr., and Project Supt.; Draftsman, Corps of Engrs., U.S. Army, Tulsa.

MARR, JOHN GENTLE (Assoc. M.), Oakland, Calif. (Age 37) (Claims RCA 2.9 RCM 9.4) Aug. 1937 to date City Planning Engr.; previously Asst. Engr., City Plan Comm., St. Louis, Mo.

MAY, SAMUEL BUCHANAN, St. Louis, Mo. (Age 47) (Claims RCA 2.7 RCM 14.4) June 1916 to date (except July to Dec. 1918 2d Lieut., U.S. Army) with C. E. Smith & Co., Cons. Engrs., St. Louis, Mo., from Jan. 1928 to June 1941 being member of Board of Control and since June 1941 Mgr.

MILLER, GEORGE WARREN, Los Angeles, Calif. (Age 47) (Claims RCA 7.4 RCM 14.8) Dec. 1936 to date in private practice of structural engineering.

NEWELL, PAUL CALEB, San Francisco, Calif. (Age 49) (Claims RC 15.4 D 3.0) April 1932 to date associated with The Loveland Engrs.; also Vice-Pres. Santa Rosa Water-Works (past 5 years); Pres. and Chf. Engr., Meridian Farms Water Co. (past 3 years).

PEACOCK, FREDERIC LOCKWOOD (Assoc. M.), Washington, D.C. (Age 52) (Claims RC 18.2 D 10.1) June 1913 to date Field Engr., U.S. Coast & Geodetic Survey, part of time being Commanding Officer on ships.

TASHJIAN, ARMEN HAIGOUNI, Cleveland, Ohio. (Age 59) (Claims RCA 8.2 RCM 23.5) 1939 to date Cons. Engr. for Union Metal Mfg. Co., Canton, Ohio, on foundation problems; 1912 to 1921 Engr., and 1921 to 1939 Engr. member of firm, Walker & Weeks, Archts. Cleveland.

APPLYING FOR ASSOCIATE MEMBER

ADAMSON, PAUL LESLIE, Bakersfield, Calif. (Age 33) (Claims RCA 5.2) March 1941 to date Res. Engr., Kern County, Calif.; previously Asst. Hydr. Engr., California Div. of Water Resources; Jun. Bridge Engr., California Div. of Highways.

AKINAKA, ARTHUR YOSHINORI, Honolulu, Hawaii. (Age 32) (Claims RCA 2.5) July 1941 to date private practice as Civ. Engr. and Surveyor; April 1938 to June 1941 Asst. Planning Engr., Territorial Planning Board, Honolulu; previously with U.S.Q.M. and U.S. Engr. Office.

BARNETT FRANCIS VICTOR (Junior), Monroe, La. (Age 32) (Claims RCA 3.4) June 1931 to date with United Gas Public Service Co., successively as Draftsman, Engr., and (since Feb. 1938) Dist. Engr.

BAUKNIGHT, WILFRED (Junior), Pittsburgh, Pa. (Age 30) (Claims RCA 5.0 RCM 3.5) June 1933 to date with U.S. Engr. Office as Inspector, Jun. Engr. (Civil), Asst. Engr. (Civil), and (since Feb. 1940) Associate Engr. (Civil).

BISSETT, JAMES ROBERT, Junction, Tex. (Age 31) (Claims RCA 4.3) Sept. 1939 to June 1941 student, and (after Dec. 1940) Student Asst., Dept. of Civ. Eng., Univ. of Tex.; previously with Texas Highway Dept., as Rodman, Asst. Office Engr., Instrumentman, and Field Engr.

BORDERS, COY W., Waco, Tex. (Age 32) (Claims RCA 2.0) 1941 B.S. in Civ. Eng., A. & M. Coll. of Tex.; at present Acting City Engr.; Feb. 1931 to May 1934 and Sept. 1934 to Sept. 1939 with Texas State Highway Dept., as Office Asst., Plant and Mixer Inspector, and Senior Inspector, etc.

BRUCE, JOHN FREDERICK (Junior), Portland, Ore. (Age 32) (Claims RCA 2.7) Sept. 1936 to April 1937 and May 1939 to date with U.S. Army Engrs., as Topographic Draftsman, Jun. Engr., and (since Feb. 1941) Asst. Engr., being group Chief; in the interim with Henningson Eng. Co., and Central Nebraska Public Power & Irrigation Dist.

BURR, KENNETH RAYMOND, Bremerton, Wash. (Age 34) (Claims RCA 2.7 RCM 3.5) May 1940 to date at Puget Sound Navy Yard, as Asst. Naval Archt., Scientific Group, Design Sec., Planning Div., and since Jan. 1941 Associate Civ. Engr. (Constr.), Contr. Sec., Public Works Div.; previously with Bridge Div., Michigan State Highway Dept., as Bridge Project Engr., and Bridge Designing Engr.

CHING, QUAN YUEN, Honolulu, Hawaii. (Age 32) (Claims RCA 2.5) Oct. 1940 to date Chf. of Party, Turner Constr. Co., Pearl Harbor, Hawaii; previously Senior Structural Draftsman and Jun. Civ. Engr., U.S. Engr. Office, Honolulu.

CLAIRE, WILLIAM HAYWARD, Cheyenne, Wyo. (Age 30) (Claims RCA 1.2) Nov. 1940 to date Asst. Civ. Engr. with Royce J. Tipton, Cons. Engr.; previously Estimator and Detailer, Colorado Builders' Supply Co., Denver, Colo.; Instrumentman, WPA, Boulder County, Colo.

CULTICE, JAMES MARVIN (Junior), Alexandria, Va. (Age 32) (Claims RCA 3.7) Oct. 1935 to date with RA, Washington, D.C., as Tech. Asst. to Associate Director, Jun. Engr., Asst. Engr., etc., and (since Dec. 1937) Asst. Engr. in charge of Research Unit of Aerial Photographic Laboratory, AAA, U.S. Dept. of Agriculture.

DAMES, TRENT RAYSBROOK (Junior), Los Angeles, Calif. (Age 29) (Claims RCA 4.4 RCM 2.0) Aug. 1938 to date in private practice as T. R. Dames and (since Nov. 1938) as Dames & Moore; previously with Robert V. Labarre.

DILLINGHAM, MARION ALFRED (Junior), Galveston, Tex. (Age 32) (Claims RCA 6.3) May 1930 to date with U.S. Engr. Office at St. Louis, Mo., Mineral Wells and Galveston, Tex., as Jun. Engr., Asst. Engr., Associate Engr. and (at present) Engr.

DUNLOP, JOHN ARLINGTON (Junior), Troy, N.Y. (Age 32) (Claims RCA 1.0) June 1930 to June 1940 Instructor in civil engineering, and June 1940 to date Asst. Prof. of geodesy and transportation engineering, Rensselaer Polytechnic Inst.

EBUR, CLIFFORD WHEATON, JR. (Junior), Pittsburgh, Pa. (Age 32) (Claims RCA 3.0 RCM 1.5) May 1937 to date Senior Draftsman, Survey Sec., U.S. Engr. Office; previously Draftsman, B.A.E., Graphic Sec., U.S. Dept. of Agriculture, Washington, D.C.

EDDY, WILLIAM CLYDE, Lincoln, Nebr. (Age 37) (Claims RCA 12.0) June 1931 to date with Nebraska Dept. of Roads and Irrigation as Instrumentman, Jun. Engr., Senior Engr., Asst. Chf. Draftsman, Asst. Office Engr., and Asst. Engr. of Maps and Plans.

ENGLER, LESLIE WINFRED (Junior), New York City. (Age 32) (Claims RCA 2.0) Feb. 1934 to Jan. 1937 Tutor, and Jan. 1937 to date Instructor, Civ. Eng. Dept., Coll. of City of New York.

GEAR, HARRY COMPTON, Dallas, Tex. (Age 34) (Claims RCA 5.0) May 1929 to date with Lone Star Gas Co., as Asst. Valuation Engr. and (since April 1930) Asst. Engr.

GERSTNER, MERRILL ANTHONY, New Orleans, La. (Age 32) (Claims RCA 4.1 RCM 3.1) May 1941 to date Asst. Engr., Barnard, Godat & Heft, Cons. Engrs., New Orleans; previously Detailer, J. G. White Eng. Corporation; Senior Road Designer, Louisiana Dept. of Highways.

GILDEA, ALBERT PATRICK (Junior), Glendale, Calif. (Age 32) (Claims RCA 3.2) Aug. 1937 to date with U.S. Engr. Office, Los Angeles, Calif., as Jun. Engr., and since Oct. 1931 Asst. Engr.; previously with U.S. Waterways Experiment Station.

GUILDAY, JOHN WILLIAM, Mt. Vernon, N.Y. (Age 43) 1934 to 1936 and May 1937 to date Engr. with Maurice R. Scharff, New York City, public utility studies, etc.; in the interim with Water Resources Comm., Washington, D.C., as Prin. Asst. Engr., Administrative Asst. to Director of National Drainage Basin Study, and Engr.

HEISELMAN, CHRISTOPHER FRANK, Lackawack, N.Y. (Age 35) (Claims RCA 6.6) Dec. 1938 to date Eng. Inspector, New York City Board of Water Supply; previously Asst. City Engr., and Supt. of Public Works, Kingston, N.Y.

HOGAN, GEORGE ELMER, Palo Alto, Calif. (Age 52) (Claims RCA 1.9 RCM 13.4) Jan. 1941 to date Designer, Bethlehem Steel Co., Risdon Plant, San Francisco, Calif.; previously Designer and Supt. of Constr. for Intercontinental Rubber Co. of New York; with Western Pipe Steel Co., etc.

HOPKINS, HOLLIS HUGHES, JR., Baltimore, Md. (Age 31) (Claims RCA 4.5) April 1941 to date Engr., M. of W., Baltimore & Ohio R.R.; previously with Office of Quartermaster General, Constr. Q.M., Washington, D.C.; with Office, Chf. of Engrs., War Dept., Washington; with U.S. Engr. Office, Baltimore.

JACOBSON, CECIL BALTZAR, Denver, Colo. (Age 31) (Claims RCA 3.8) Sept. 1933 to date (except Feb. to May 1941 graduate student) with Dept. of Interior, U.S. Bureau of Reclamation, as Eng. Draftsman, Jun. Engr., Asst. Office Engr., and Asst. Engr., at present with Water Resources Div., Denver, Colo.

JARCHO, SAUL MATRI (Junior), Tel-Aviv, Palestine. (Age 33) (Claims RCA 6.5) Jan. 1935 to date Asst. Engr., Dept. of Sewers, Tel-Aviv Municipality, Palestine.

KAPPE, STANLEY EDWARD (Junior), Washington, D.C. (Age 32) (Claims RCA 0.4 RCM 9.8) Sept. 1936 to date with Chicago (Ill.) Pump Co., as Dist. San. Engr., eastern and coastal states; previously with U.S. Engrs., Philadelphia, Pa., Dist.

LANDAUER, LEO LEVY, Dallas, Tex. (Age 33) (Claims RCA 4.0 RCM 7.5) 1934 to 1941 member of firm, Kribs & Landauer, Cons. Engrs., Dallas and Houston, and at present Cons. Engr., Dallas.

MACAULAY, JAMES EARL, Buzzards Bay, Mass. (Age 37) (Claims RCA 5.2) June 1939 to date Structural Engr., U.S. Coast Guard, Boston; previously Field Engr., WPA; Dredging Inspector, U.S. Engrs., Cape Cod Canal, Bourne, Mass.; Surety Engr., Massachusetts Bonding and Insurance Co., Boston.

MACFARLANE, CARL CECIL, Lawrence, Kans. (Age 32) (Claims RCA 2.2) Sept. 1938 to June 1941 (while student) Instructor, Univ. of Kansas; Nov. 1933 to Sept. 1938 with Kansas Highway Comm., as Instrumentman, Engr., and Engr. Draftsman.

MCNEAR, ROBERT BARTON, Elmhurst, Ill. (Age 31) (Claims RCA 3.1 RCM 4.7) Oct. 1933 to date with International Filter Co., Chicago, Ill., as Installation and Service Engr., Field Representative, and (since Nov. 1936) on supervisory sales engineering.

MARYE, EDWARD AVONMORE, Louisville, Ky. (Age 39) (Claims RCA 15.4) July 1935 to date State Engr., and State Director of Operations, etc., Kentucky WPA.

MESSER, MERTON WILLIAM, Birmingham, Ala. (Age 38) (Claims RCA 9.8 RCM 0.7) Oct. 1940 to date Sales Engr., The Superock Co., Birmingham; previously Arch. Examiner, FHA; Engr. Sales Clerk, Connors Steel Co.

NORRIS, WALTER THOMAS, San Francisco, Calif. (Age 33) (Claims RCA 3.3 RCM 0.5) March 1941 to date Dist. Engr., Am. Inst. of Steel Constr.; previously Engr., Designer, Estimator, and Designing Engr., Moore Dock Co.; Designing Engr., Permanente Corporation, San Jose, Calif.; with Ingalls Iron Works.

SMITH, RALPH CARL, Spokane, Wash. (Age 47) (Claims RCA 15.5) 1941 B.S.C.E., State Coll. of Wash.; Feb. to Aug. 1940 Prin. Inspector of construction, Kodiak (Alaska) Naval Air Base; Feb. 1920 to Feb. 1940 with State Dept. of Highways, Washington, as Res. Engr., Transitman, Locating Engr., etc.

WELDY, FREDRICK WASHINGTON, Tuscaloosa, Ala. (Age 41) (Claims RCA 8.6) Feb. 1933 to date with Alabama Highway Dept., as Res. Engr., Asst. Maintenance Supervisor, Res. Engr. Supt., Div. Bituminous Engr., and (since March 1939) Asst. Div. Engr., Maintenance.

WILSON, EDMUND POWELL, Wilkes-Barre, Pa. (Age 35) (Claims RCA 4.0 RCM 4.0) 1937 to date Development Engr., American Cable and Hazard Wire Rope Divs., American Chain & Cable Co., Inc.

WYMAN, ALTON BERTRAM (Junior), Portsmouth, Ohio. (Age 29) (Claims RCA 2.2) May 1939 to date Engr. Inspector, and later Planning Engr., City of Portsmouth; previously Supt., C. A. Yeager & Co., Bldg. Contr.; Timekeeper and Field Engr. for S. Monroe & Son Co., Road Contr.; Park Project Supt., Portsmouth.

APPLYING FOR JUNIOR

BENTON, ROBERT TYRIE, Caracas, Venezuela. (Age 26) Jan. 1939 to date Surveyor, Mott-Smith Corporation of Houston, Tex.; previously Engr., Florida Tropical Acres, Inc., New Smyrna Beach, Fla.; with U.S. Engr. Dept. in various capacities.

BLAKE, ROBERT LOGAN, Prescott, Ariz. (Age 26) 1937 B.S. in C.E., Univ. of Ariz.; Aug. 1939 to date Jun. Hydr. Engr., U.S. Geological Survey; previously Draftsman, City of Tucson, Ariz.

DENNISON, JOHN TAYLOR, Nashville, Tenn. (Age 31) (Claims RCA 6.3) Sept. 1939 to date Senior and Prin. Draftsman (Structural), U.S. Engrs.; previously with U.S. Forest Service as Subsurveyman, Acting Supt. and Supt. of CCC Camps, etc.

FALLON, RICHARD GORDON, Hollis, N.Y. (Age 25) (Claims RCA 2.0) June 1938 to date Field Draftsman and Office Engr., Madigan-Hyland, Cons. Engrs., Long Island City, N.Y.; previously Draftsman, Carroll-McCreary, Inc., Maspeth, N.Y.; Engr., Brooklyn (N.Y.) Union Gas Co.

HARRIS, ROBERT SHELDON, Albuquerque, N.Mex. (Age 31) Dec. 1938 to date with U.S. Indian Service as Jun. Engr., Irrigation Div., and (since May 1941) Asst. Engr.; previously Instrumentman and Draftsman, City of Albuquerque; Eng. Foreman, National Park Service.

KIRKLAND, WILLIAM GALLUCHAT, Brooklyn, N.Y. (Age 27) Sept. 1940 to date Senior Drafting Engr., Planning Div., Scientific Sec., Navy Dept., Brooklyn Navy Yard; previously Asst. to Supt. of Bldgs., Southwest Co. and Times-Mirror Co., Los Angeles, Calif.; Draftsman with R. C. Yinger, Archt., Los Angeles.

KLINDT, PEDRO, Caracas, Venezuela. (Age 27) (Claims RCA 1.7) June to Sept. 1937 Asst. Engr., Sewerage Dept., and Sept. 1937 to date Asst. Engr. and Designing Engr., etc., Water Works Dept., Ministry of Public Works of National Govt., Venezuela; previously Surveyor, Topographic Dept., Caribbean Petroleum Co., Maracaibo, Venezuela.

LE FEVRE, WILLIAM FRANCIS, JR., Jefferson City, Mo. (Age 23) 1939 B.S. in C.E., Univ. of Colo.; has completed all requirements, except thesis, for M.C.E.; Feb. 1941 to date Soils Engr., Missouri Highway Dept.

POSPICK, WILLIAM ROBERT, Austin, Tex. (Age 30) June 1940 to date with Texas Highway Dept. with Div. of Materials and Tests, as Jun. Laboratory Asst. and (since April 1941) Laboratory Asst.; previously with Dept. of Public Works, Dallas.

TINDAL, LEVY RHAME, Washington, D.C. (Age 30) Feb. 1941 to date Senior Structural Draftsman, National Advisory Comm. for Aeronautics, Langley Field, Va.; previously with Virginia Dept. of Highways, Richmond, Va., as Highway Draftsman (Jun.), Highway Survey Draftsman, etc., and Prin. Eng. Aide, Bridge Office.

WHEELER, HENRY LEWIS, JR., Compton, Calif. (Age 26) (Claims RCA 0.2) 1940 B.S. in Gen. Eng., Univ. of So. Calif.; June 1940 to date Apprentice Engr., Substation Dept., So. California Edison Co., Los Angeles, Calif.

1941 GRADUATES

UNIV. OF AKRON (B.C.E.)

	Age
CHAPMAN, DEAN EDWARD	(22)
CORNS, CHARLES FRANKLIN	(23)
LAUGHLIN, JOHN VICTOR	(21)
MARKEY, WILLIAM FLETCHER	(23)
MONTGOMERY, PAUL BYRON	(25)

ALA. POL. INST. (B.C.E.)

BUNCH, MORGAN WIMBERLY	(22)

UNIV. OF ARK. (B.S.C.E.)

ADKINS, MARVIN CECIL	(22)
BULLARD, PETE MARSHALL	(22)
HOWELL, LAURENCE LAWTON	(21)
VOLLMAN, PERSHING HAIG	(23)

BROOKLYN POL. INST. (B.C.E.)

BEER, ROBERT LOUIS	(22)
FUSCO, MICHAEL ANTHONY	(23)
GREENBERG, SIMON ALLYN	(26)
MILASHEFSKY, ALFRED BORIS	(22)
WHALEN, ARTHUR	(22)

BROWN UNIV. (Sc.B. in Eng.)

ALLEN, WILLIAM FREDERICK, JR.	(22)
HARRINGSON, EARL WHITTEMORE, JR.	(21)
HIBBERT, NORMAN LEE	(22)
WILMOT, ROBERT STANLEY	(21)

CALIF. INST. TECH. (B.S. in Civ. Eng.)

CARLSON, CARL ARTHUR	(21)
LAKOS, EUGENE ALEXANDER	(22)
SILBERSTEIN, RICHARD FREDERICK	(23)
VAUGHAN, RICHARD MCKOWN	(21)
VEY, EBENEZER	(27)

(M.S. in Civ. Eng.)

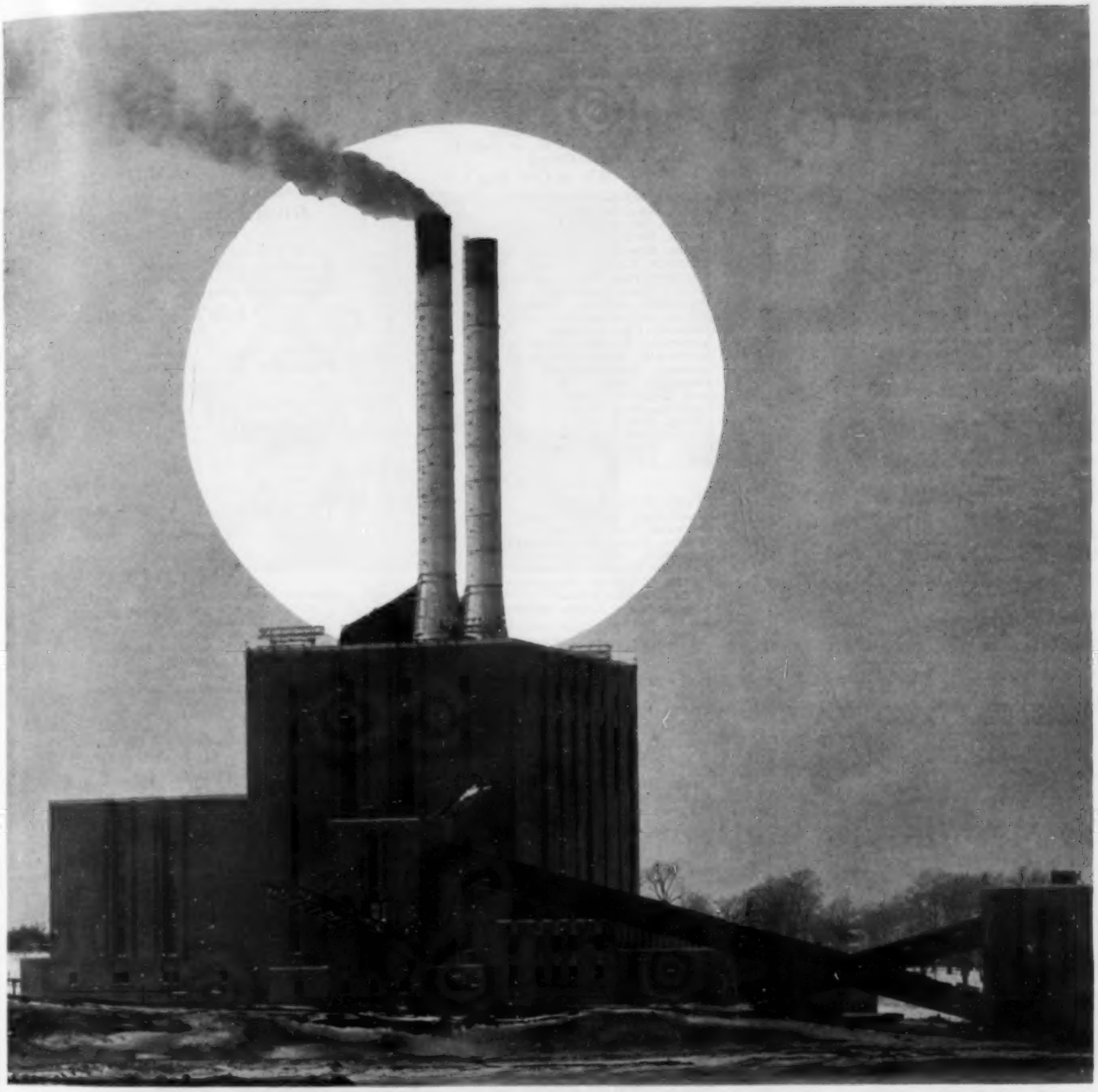
COBB, CHARLES LEWIS (also 1940 B.S. in C.E., Univ. of Notre Dame)	(22)
WAIGAND, LEROY GRAM (also 1940 B.C.E., Ohio State Univ.)	(23)

UNIV. OF CALIF. (B.S. in Civ. Eng.)

ALTMAN, HENRY	(24)
AMSTER, ALVIN ALBERT	(24)
BARNETT, LOREN MERLE	(23)
BELL, JOHN WRIGHT	(23)
BLOWER, HOWARD EDWARD	(22)
BOLTON, GEORGE NEILSON	(21)
BOND, CHARLES FORREST	(21)
BUSSELL, JOHN EDWARD	(21)
COLLIN, ALVARO LOUIS	(24)
CRANDALL, LIONEL LEROY	(24)
DIERKER, FRED HERMAN	(23)
ERSKINE, PAUL BAKER	(23)
GARRETSON, BRADLEY BURNETT	(21)
GIANELLI, WILLIAM REYNOLDS	(22)
GROESBECK, STEWART WINN	(23)
HINK, CLEMENT WARREN	(23)
HORN, WILLIAM LOUIS	(25)
HUNT, THOMAS DAVID	(22)
JESPERSEN, ROBERT JOHN	(23)
JONES, JOHN HUGH	(22)
KLIPPEL, GORDON HAYWARD	(22)
KNEILING, JOHN GILBERT	(21)
KRUEGER, WILLIAM JENSEN	(22)
LEE, LESTER HUNG	(22)
LOWE, ROBERT PEARSON	(29)
LUDWIG, RUSSELL GEORGE	(21)
MARSHALL, FREDERICK CHARLES	(24)
MENDENHALL, IRVAN FRANK	(23)
MURDOCH, ROBERT ROY	(23)
OLSON, CARL ALEXIUS, JR.	(21)
PELETZ, CYRIL MORTON	(22)
PEREZ, ROBERT PAUL	(23)
POND, WENDELL FRANCIS	(23)
RITCHEY, ROBERT MANLEY, JR.	(23)
ROSTRON, JAMES THOMAS	(23)
RUNDE, HOWARD NORMAN	(26)
RUVKUN, SAM	(21)
SALOMON, JEROME LEONARD	(22)
SHACKELFORD, BARTON WARREN	(20)
SHATTO, HARRY HOWLAND	(25)
SMITH, BURTON LOYAL	(25)
SODERSTRAND, JOSEPH NORMAN	(21)
SORENSEN, JAMES FRANCIS	(21)
STICKEL, RICHARD ELWIN	(23)
TAYLOR, HOWARD GEORGE	(22)
TAYLOR, JOSEPH EDWIN	(23)
TOLTON, WILLIAM RUSSELL	(23)
WILLIAMS, ROBERT GARRETT	(22)
WILLIAMSON, ROBERT ANDREW	(25)
WRIGHT, JOHN EARL	(23)
ZAPP, FRITZ	(30)

CASE SCHOOL OF APPLIED SCI. (B.S. in C.E.)

BACKLOND, MAUNO OLIVER	(29)
BROSTA, JOSEPH	(30)
BYERS, EDWARD FRANKLIN	(24)
GIFFORD, JACK BRENNAN	(21)



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Yohalem, Martin Justin (21)

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Diehl, John Anthony (24)
Graham, Harry Thomas (21)
Meier, James Edward (25)
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Richards, William French, Jr. (22)

CLEMSON COLL.
(B.C.E.)

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(B.S. in A.E.)

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Fountain, Joseph William (23)
Hogue, Walter Robert (22)
Kelsall, Fred Anderson (20)
Tamminga, Samuel William (23)

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Case, Douglas (22)
Clayton, Leslie Allison (22)
Docter, Eugene Wilson (25)
Dodson, Stanley Leroy (23)
Jacobson, Oscar Bayard (23)
McNeill, John Levis (32)
McQuaid, Daniel Joseph, Jr. (24)
Morgan, George Herbert (24)
Ruddell, Roy Major Alexander (23)
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Ten Eyck, Thomas Willard (21)
White, Kenneth Ray (22)

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Blakely, Matthew Louis (22)
Bottomley, Herbert Hanford (23)
Garbus, Julius (22)

COOPER UNION
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Bobay, Paul (22)
Kaufman, Herbert Leonard (22)
Pavelka, Stephen (23)
Pinto, Charles Joseph (26)
Scheinbart, Irving (21)
Servedson, Edwin Henry (24)
Weniger, Sidney (21)
Wintoniak, Simeon George (22)

CORNELL UNIV.
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Eckerlin, Howard Frederick (24)
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Hario, Frank Eugene (23)
Lewis, Carl Grady (22)
Schnurr, Francis Maurice (21)
Smith, Hugh Michael (22)
Wohlschlaeger, Joseph Aloysius (22)
Ziegler, Ramon Denton (22)

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Eckman, Robert Wirt (22)
Fooks, Jack Herbert (23)

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Drew, William Donald (22)

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Funderburk, Horace Boyce, Jr. (24)
Livingston, Edward Ernest, Jr. (21)
Van Arsdale Harold Charles (21)

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(M.S.)

Watkins, George Reynolds (25)
(Also 1938 B.S. in Civ. Eng., Univ. of Ky.)

UNIV. OF IDAHO
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Brown, Robert Covey (25)
Cox, Everett Lee (26)
Dalton, James Cecil (22)
Gordon, Glenn Coates (23)
Marsh, Phillip Andrew (23)
Nesbitt, Elmer Kenward (25)
Smith, Edward Roos (23)
Stanton, Edgar Williams, III (25)
(Also 1939 B.S. in Forestry)
Ward, Jack Warren (22)

ILL. INST. TECH.
(B.S. in C.E.)

Brinkerhoff, Cleaver Henry (23)
Hauswald, Arthur Charles (22)
Rolb, Harry (22)

UNIV. OF ILL.
(M.S. in Civ. Eng.)

Chang, Arthur Cheng Chung (24)
(Also 1940 B.S. in C.E., St. John's Univ., Shanghai, China)

(B.S. in Civ. Eng.)

Abrams, Michael Melvin (22)
Bills, William Francis (22)
Brown, Spencer Francis (21)
Busse, Wilbur Edward (22)
Chase, Robert Addison (23)
Compton, Kenneth Lyle (31)
Eckenfelder, Melvin Christian (23)
Emert, Gene Carroll (22)
Harmeson, Robert Harold (21)
Janda, Benjamin Hubert (20)
Johnson, Oscar Lloyd (29)
Kroening, Henry Frank (25)
Montooth, Marvin Richard (22)
Murray, James Robson (22)
Pershing, Jack (22)
Ray, Gordon Keith (22)
Shay, George Richard (22)
Spires, Alfred Moss (21)
Strandberg, Arnold Oscar (22)
Wolf, Walter Woebel (21)
Zeman, Joseph Michael (28)

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Brown, Eugene Louis (21)
Galowitch, Werner Fred (22)
Hoerner, John Everett (25)
Miller, Bernard Langdon (26)
Peterson, Arnold Anton (24)
Phillips, Gordon Albert (21)
Pitter, Cuthbert Altamont Linton (29)
Quick, Boyard Rollin (21)
Santostefano, Oscar Benny (23)
Wille, Parke (24)

IOWA STATE COLL.
(B.S. in Civ. Eng.)

Cords, Walter Donald (25)
Huептle, Kurt Max (23)
Wentz, John Budd (21)
Wilson, Charles Webster (22)

STATE UNIV. OF IOWA
(B.S. in Civ. Eng.)

Davis, Donald Charles (24)
Dawson, John Howard Heaton (21)
Weremy, Alexander (23)

THE JOHNS HOPKINS UNIV.
(B.C.E.)

Bauer, George Jackson (20)
Euler, Louis Mohr (20)
Homburg, Albert Henry, Jr. (21)
Knoop, Fredrick Rippel, Jr. (21)
Machis, Alfred (20)
McCord, Kenneth Armstrong (20)
Mattheiss, Theodore Henry, Jr. (21)
Witten, Louis (20)

KANS. STATE COLL.
(B.S. in Civ. Eng.)

Bond, Emory, Jr. (24)
Childers, Garland Baxter (21)
Eshelman, Aven Lamar (24)
Giddings, Elvin Vance (22)
Helm, Carl Henry (24)
Scanlan, Melvin Eugene (24)

UNIV. OF KANS.
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Bales, Byron William (23)
Fogel, John Martin (22)
Hammond, Clarence Thomas (22)

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Birkel, Louis Ferdinand, Jr (22)
Gohmann, Herbert Raymond, Jr. (21)

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Alford, Wilson Merriman (21)
Hagensen, Carl Philip (30)
Hoyt, John Folsom (21)

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Barry, Francis Thomas (21)
Henel, William Frederick (22)
Mathias, William Joseph Maxwell (21)
Naughton, John Francis (23)
Romano, Frank Albert (22)
Ryan, John William, Jr. (23)

MARQUETTE UNIV.
(B.C.E.)

Austin, Frank Joseph (23)
Kumm, Arthur William Fredrick, Jr. (24)
Roberts, Emory Gilman (22)

MASS. INST. TECH.
(S.B.)

Brannan, John Hayes (22)
Macleod, John Holmes, Jr. (21)
Moffet, Clifford Everett (22)
Taylor, Robert David (21)
Thompson, Josephine Gladys (Miss) (23)
Turansky, Walter (22)

(S.M.)

Voodhigula, Tui (24)

MICH. COLL. OF MIN. & TECH.
(B.S. in Civ. Eng.)

Coon, Thomas Robert (24)
Feldscher, Carl Burandt (21)
Phillipich, Anthony Raymond (22)
Priniski, Rupert (27)

UNIV. OF MINN.
(B.C.E.)

Nielsen, Robert Alfred (23)
Okerlund, Chester Devine (22)

UNIV. OF MO.
(B.S. in Civ. Eng.)

Birt, William Moler (23)
Campbell, William Joseph (23)
Deal, William Humes (23)
Fields, Richard Clore (23)
Leinbach, David Singleton (23)
Nichols, Ross Oakley (21)
Oakes, Alvin M. (23)
Purdy, William Grant (23)
Sons, Charles Carol, Jr. (22)

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Chase, Francis Michael (21)
Church, Edward Howland (21)
Eckman, George (22)
Fox, Alden Eugene (21)
Parr, Harry Alfred (24)
Pike, Lloyd Franklin (25)
Smith, Richard Parker (21)
Stockwell, Donald MacArthur (23)
Townsend, Paul Arthur (21)
Wentworth, Cecil Edmund (23)

N.MEX. STATE COLL.
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Bennett, Sheldon Appleby (25)
Boise, Otis Wells (24)
Foster, Lewis Edward, Jr. (25)
Keesecker, Victor Carl (23)

COLL. OF CITY OF NEW YORK
(B.C.E.)

Brancaccio, Joseph Charles (22)
Camellerie, Joseph (20)
Cullaty, Frank Ronald (26)
Nassetta, Anthony (20)
Ness, Howard (21)
Packer, George (22)
Shamamian, Vasgen (21)

NEWARK COLL. OF ENG.
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D'Onofrio, August Arnold (21)
Dotter, Eugene Victor (20)
Ebel, Edward Ernest, Jr. (20)
Held, William (22)
Julian, Romolo Ronald (23)
McGee, Thomas Vincent, Jr. (22)
Mandell, Louis Philip (23)
Nechwort, George Franklyn (22)
Portnoff, Irving (24)
Skurla, Peter John (22)
Strohl, LeRoy Sterling, Jr. (30)
Wulfers, John Wilbur (23)
Zuest, Wilbert Henry (25)

N.C. STATE COLL.
(B.C.E.)

Fox, Harrison William (21)

M.C.E.

Grady, Robert Howell (24)
(Also 1938 B.S.C.E.)

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(B.S. in Civ. Eng.)

Jackson, Donald Hugh (28)

OHIO STATE UNIV.
(B.C.E.)

Apple, Donald William (21)
Keysor, Carl Ellsworth (22)
Kurtz, Charles Henry, Jr. (23)
Lersch, William Harwood (22)
Stamm, Paul Quentin (22)
Sunbury, Roger Dwight (23)
Underwood, Roy Traxel (22)

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Winters, Alfred Calvin (29)

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Alexander, William Anthony (26)
Bonney, Robert Milton (22)
Ebeling, Dick Windfield (22)
Keasey, Richard Alden (30)
Naillon, Jacob Duane (23)
Steinbrugge, Karl Vathauer (22)
Wallace, Henry Newman, Jr. (24)

PA. STATE COLL.
(B.S. in Civ. Eng.)

Butler, Allen George (24)
Rohrer, Charles Emerson (27)
Tamanini, Flory John (23)

UNIV. OF PITTSBURGH
(B.S. in Civ. Eng.)

McCabe, William Patrick (21)

RENS. POL. INST.
(B.C.E.)

Carr, Donald Edward (22)
Chong, Wah Jan (23)
Haybrook, Stephen Howard (23)
Tocher, Frank Laurain (25)
Wicks, William Stanton (21)

R.I. STATE COLL.
(B.S.)

Repass, George Herbert (22)

RICE INST.
(B.S. in C.E.)

Austin, Walter James (21)
Dean, Olney Joseph, Jr. (22)
Sale, Joseph Archie (22)
Sims, James Redding (23)

UNIV. OF SO. CALIF.
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Costales, Bernard Raoul (26)
Franklin, Robert Evans (22)
Ragenovich, Walter (21)
Yates, Francis Gordon (23)

STANFORD UNIV.
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Viscovich, Steven Joseph (24)
(Also 1939 A.B. in Eng.)
Wise, Lauress Lee (22)
(Also 1939 A.B. in Eng.)
Yoder, Marion Carleton (27)
(Also 1939 A.B. in Eng.)

(A.B. in Eng.)

Wunderlich, Frederick Winslow (21)

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(B.S. in Civ. Eng.)

Degutis, Anthony Joseph (21)
Drury, Richard Boone (21)

UNIV. OF TENN.
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London, Jack Daniel (23)
Winn, William Buford (25)

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Braswell, Clarence David (22)
Burklin, William Boyd (23)
Carnes, George Knox (22)
Christian, Charles Britton (22)
Cooper, Carroll Woodrow (24)
DeVilbiss, Cecil Floyd (27)
Drumwright, Henry Elmo (21)
French, Leslie Ferris (21)
Gray, Sherman Grant (23)
Haynes, Wade Light (26)
Hough, Leonard Elijah, Jr. (24)
Loven, Cullen Isom (24)
Pillow, Ward Bullock (24)
Yarbrough, David Bert (22)

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(B.S. in Civ. Eng.)

Bowden, Adrain C. W. (22)
Griffin, Etchel Earl (25)

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(B.S. in Civ. Eng.)

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Cook, Thomas Edward (21)
Dieter, Philipp George, Jr. (23)
Mitchell, Francis Eugene (28)
Nau, Henry Hardt (23)
Ramey, Madison Louie (21)
Seamans, Douglas Campbell (22)
Seamans, Lynn Andrew (21)
Smith, Roy Thomas, Jr. (23)

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Bixby, Paul (21)
Zidel, Mischel (22)

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Ory, Francis Joseph (20)
Painter, Stephen Wallace, Jr. (25)
Ricker, Paul Harding (22)

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Fuhriman, Dean Kenneth (23)
Gessel, Clyde David (23)
Skidmore, Wallace Elbert (24)
White, Robert Ernest, Jr. (22)
Wilding, Malin Telford (27)

UNIV. OF UTAH
(B.S. in C.E.)

Cannon, Collins Burton (23)
Turner, William Roylance (23)

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Dobyns, Samuel Witten (21)
Kaiser, Frederick Ferdinand (20)
Louthan, Frank Garrett, Jr. (20)
Modisett, Shirley Augustus (21)
Nelson, Andrew Leslie (22)
Wilson, Walter Brownlee, Jr. (23)

VA. POL. INST.
(B.S. in Civ. Eng.)

Via, Charles Edward, Jr. (23)

WASH. STATE COLL.
(B.S. in Civ. Eng.)

Cheatham, Fred Russell (22)
Dillon, Jack G. (21)
Erikson, Lester O. (21)
Mangan, John (24)
Skrinde, Raymond Arthur (22)
Taylor, Lorne Gene (23)

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Meserve, Earl Charles (28)
Vollmar, Joseph Edward, Jr. (21)

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Finner, Glenn Frederick (21)
Fintak, Gerald George (23)

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(B.S. in Civ. Eng.)

Anderson, Roland Napoleon (25)
Nystrom, Paul Godfrey (23)
Parks, Russell Whidden (21)

UNIV. OF WYO.
(B.S.C.E.)

Gawthrop, Robert Charles (25)
Genetti, Frank Victor (22)
Gish, Malcolm Dean (23)
(Also B.S. in Mech. Eng.)
Kester, Harold Osborn (27)
Knight, Frank Millen (25)
Koski, Leonard (25)
Lewis, Donald William (22)
Maxson, Frank Brierley (25)
Saunders, Howard Bertram (22)
Seipt, Robert Morris (23)
Shawver, Guy Ernest (28)
Woltersdorf, Donald Byron (21)
Zoller, James Harold (21)

YALE UNIV
(B.E.)

Anderson, James Thomas (22)
Owen, John Walker (24)
Robinson, Willard Charles (21)
Skelton, Ray Hamilton, 2d (20)

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men and Positions Available

These items are from information furnished by the Engineering Societies Personnel Service, with offices in Chicago, Detroit, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 141 of the 1941 Year Book of the Society. To expedite publication, notices of positions available should be sent direct to the Personnel Service, 31 West 39th Street, New York, N.Y. Employers and applicants should address replies to the key number, care of the New York Office, unless the word Chicago, Detroit, or San Francisco follows the key number, when it should be sent to the office designated.

Construction

Construction Engineer; Jun. Am. Soc. C.E.; 33; married; graduate C.E.; 10 years varied experience on highways, bridges, steel and general building construction; now employed as chief estimating engineer with general construction doing more than ten million dollars worth of work annually; desires offer of responsible position with construction company. C-862.

Junior

Civil Engineer; Jun. Am. Soc. C.E.; 27; married; B.S.C.E., Georgia School of Technology, 1935; 6 years railroad maintenance, design, drafting, and surveying experience; 6 months Air Base design and construction; desires work in building (construction or design) field. C-859.

Miscellaneous

Highway Engineer; Assoc. M. Am. Soc. C.E.; registered professional engineer; 20 years experience, designer, chief designer, and office engineer; past 9 years in charge of business and engineering office. Specialized in office organization, management, and highway design. Available on one week's notice. C-861.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 40; married; C.E., Cornell University; 15 years experience with steel company in shop-production supervision, field construction, design calculations, and estimating pertaining to suspension bridges and suspension-type structures; also 3 years water-supply investigation with U.S. Geological Survey. Employed. Desires new location. C-863.

Sales and Research

Sales and Research Engineer; Assoc. M. Am. Soc. C.E.; M. Soc. A.E.; B.S.C.E., 1924; C.E., 1926; married; 2 years graduate work; 6 years design and construction pertaining to transportation field; 9 years research and sales promotion, automotive parts, fuels, lubricants, and anti-knock compounds; now employed but desires position offering more responsibility of an administrative or sales executive type. C-860.

Positions Available

Designers, Structural Engineers, who have had experience in structural steel building design of a similar nature to that employed in power plant construction. Salary, to $3,300 a year. Duration, about two years. Location, New England. Y-8124.

Structural and Concrete Designers, preferably experienced in heavy building construction, power plants, etc. Salary, $3,000-$3,600 a year. Location, Pennsylvania. Y-8189.

Designer, graduate civil engineer, who has had about 10 years' experience in the design of structural steel and reinforced concrete bridges.

Salary, $3,300 a year. Permanent position. Location, New York Metropolitan Area. Y-8273.

CONSTRUCTION ESTIMATOR, 37–47, who has had considerable experience with a general contractor. Must be able and capable of assuming full responsibility of competitive bid estimating. Material take off man not wanted. Applicant must know material and labor costs. Position permanent. Salary open. Location, New York, N.Y. Y-8308.

DESIGNERS AND DRAFTSMEN, 30–45, experienced in water supply and sewerage disposal. Salaries, foreign, $4,600; New York, $3,200 a year. Locations, Central America and New York. Also desire Topographical Draftsman experienced in mapping fairly rugged country. Salary, $2,700–$3,200 a year. Location, Central America. Y-8310.

DISTRICT SALES MANAGER, 35–45, experienced in the sale of fabricated steel. Apply only by application. Location, East. Y-8327.

ESTIMATORS, who have had considerable experience in estimating chemical plant construction and equipment. Must be qualified to assume responsibility. Salary, $4,000 a year. Location, New York, N.Y. Y-8370.

DESIGN ENGINEER, 30–40, who is proficient in concrete, timber, and steel design with outstanding mathematical ability and capable of taking care of a small drafting room. Excellent opportunity. Permanent. Salary, about $4,000 a year to start. Location, New England. Y-8393.

CIVIL ENGINEER, who has had 6 to 8 years' experience in the field of railroad and track design. Salary, $3,200 a year to start. Location, South. Y-8403.

ASSISTANT PROFESSOR for department of civil engineering. Should be interested in highway engineering. Some of the work will consist of teaching elementary surveying, topographic surveying, route surveying, and higher surveying and photogrammetry. Location, South. Y-8407.

CHIEF DRAFTSMAN, who has had experience on heavy construction work, particularly marine structures, piers, docks, quay walls, and kindred structures. Applicant must be temperate in his habits. Salary, $6,500 a year. Location, West Indies. Y-8408.

STRUCTURAL DESIGNERS AND DRAFTSMEN, who have had a good background of reinforced concrete and steel. Must be citizens of the United States. Salary, $2,700–$3,380 a year. Duration, 18 to 24 months. Location, New York Metropolitan area. Y-8435.

DESIGNERS AND DRAFTSMEN. Structural, $2,000–$3,500 a year. Architectural Draftsman, $2,000–$2,400 a year. Inspectors, Construction Surveyors, Rodmen, $1,600–$2,600 a year. Assistant Civil Engineer (mapping), $2,600 a year. Field Engineer on steam power plant construction, $2,600–$3,200 a year. Application blanks may be obtained from the Engineering Societies Personnel Service, Inc. Location, South. Y-8509

ENGINEERS who have had shipyard design and construction experience, as well as shipbuilding experience. The following are positions to be filled: (1) Superintendent of Yard Construction; (2) Designing Engineering for docks and shipways; (3) Chief Draftsman and several draftsmen; (4) Field Engineer for yard construction, with Chief of Field Party and Transitman, Leveler, Rodman, Chainman, and Axeman; (5) Naval Architect with experience in shipyard design, plant layout, and steel hull and outfitting; (6) General Superintendent of steel ship construction, with experience up through the various shipyard trades; (7) Superintendent of hull (steel) construction; (8) Superintendent of outfitting; (9) Chief Loftsman; (10) Purchasing Manager; (11) Personnel Manager. Must be United States citizens. Shipyard has ten-year program. Location, East. Salaries commensurate with positions. Y-8514.

STRUCTURAL STEEL DESIGNER. Must have had experience with steel fabricators, particularly on building work. Should have gained this experience with a steel company as a designing engineer. Salary open. Location, South. Y-8531.

INSTRUCTOR in Department of Civil Engineering. Prefer applicant who has a master's degree and some teaching experience. Will be required to teach applied mechanics, strength of materials, and structures. Salary, $2,000–$3,000 for 10 months' service. Position starts September 15, 1941. Opportunity for earning additional salary by teaching extension and National Defense Training courses. Location, New England. Y-8535.

CONCRETE DRAFTSMAN with some design experience. Salary, $3,000 a year. Location, New York, N.Y. Y-8554.

DESIGNERS. Civil Engineer, 35–50, thoroughly experienced in layout of roads, water supply, sewerage, disposal plants, etc. Structural Engineer, 35–50, thoroughly experienced in concrete and steel. Must be capable of handling job from start to finish. Duration, two years. Salaries, $6,500–$7,500 a year. Location, West Indies. Y-8581.

STRUCTURAL STEEL AND REINFORCED CONCRETE DESIGNERS. Salary open. Location, Northern New Jersey. Y-8586.

DESIGNER, CIVIL ENGINEER, who has had 10 years' experience. Must be able to take charge of the design of a sewerage and water supply system for a fairly good-sized city. Salary, $6,000 a year. Duration, 6–18 months. Location, Venezuela, South America. Y-8593.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room, will be found listed here. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

AIR RAID PRECAUTIONS in ten parts, first American edition, reprinted by permission of the Controller of His Britannic Majesty's Stationery Office. Chemical Publishing Co., Brooklyn, N.Y., 1941. Diagrs., charts, tables, 9 × 5½ in., cloth, $3.

In the ten separately paged sections of this manual are brought together and amplified the materials published previously in the A.R.P. handbook and memorandum series. Topics discussed include the organization of the air-raid wardens' service, communications systems, rescue parties, and clearance and decontamination work; structural defense and window protection; gas detection and identification; training procedures and the inspection, care, and repair of equipment.

(THE) BOULDER CANYON PROJECT, Historical and Economic Aspects. By P. L. Kleinsorge with a foreword by E. Jones. Stanford University Press, Stanford University (Calif.), 1941. 330 pp., illus., diagrs., maps, tables, 9½ × 6 in., cloth, $3.50.

The whole system of related works comprising the Boulder Canyon Project (not merely the Hoover Dam construction and its resulting reservoir area) is discussed. The history of the project is reviewed, and the economic significance of this great flood control, irrigation, power, and water supply system is explained in detail. Geological and engineering aspects of the various dams, canals, and aqueducts are also considered. The book is well documented.

BRITISH CITIES AT WAR. Publication No. 76 of the American Municipal Association. By James L. Sundquist. Public Administration Service, Chicago (1313 East 60th Street), 1941. 110 pp., 10½ × 8 in., paper, $1.

This study has been written to indicate the effect of active warfare on British cities and to show how their local civil defense arrangements and their ordinary services worked in a crisis. The author has attempted to bring together information indicating the administrative problems with which British officials were faced and the measures by which they attempted to solve these problems.

DANA'S MANUAL OF MINERALOGY, 15 ed. revised by C. S. Hurlbut. John Wiley & Sons, New York, 1941. 480 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $4.

This is the fifth major revision of this standard work, now nearly 100 years old. As before, it is designed to meet the needs of the student of mineralogy, the mining engineer, the geologist, and the amateur mineralogist. In addition to alterations and additions for the purpose of bringing the material up to date, certain changes have been made to render the book more serviceable as a text for a course in elementary mineralogy.

FIELD GEOLOGY, 4 ed. revised and enlarged. By F. H. Lahee. McGraw-Hill Book Co., New York and London, 1941. 853 pp., illus., diagrs., charts, tables, 7½ × 5 in., leather, $5.

Intended both as a textbook for students and a manual for geologists and engineers, this book treats the subject of geology from a field viewpoint and assumes an elementary knowledge of general geology. The first twelve chapters are concerned with the recognition and interpretation of geologic structures and topographic forms as they are observed. The succeeding eleven chapters deal with geological surveying, computations, and preparation of reports, geophysical methods, and the nature, construction, and interpretation of geologic and topographic maps. There is a bibliography.

FOUNDATIONS OF BRIDGES AND BUILDINGS, 3 ed. By H. S. Jacoby and R. P. Davis. McGraw-Hill Book Co., New York and London, 1941. 535 pp., illus., diagrs., charts, tables, 9½ × 6 in., cloth, $5.

Completely revised and reset, this text covers the many recent developments in the field of foundation engineering. The more important phenomena in the field of soil mechanics are covered; there is new material on piling, cofferdams and caissons, grouting, and the obstruction of water flow by bridge piers; and a new chapter has been added on land foundations in open excavation, including water control.

LANDSCAPE ARCHITECTURE IN THE MODERN WORLD. By Karl B. Lohmann. The Garrard Press, Champaign (Ill.), 1941. 198 pp., illus., 9 × 6 in., cloth, $2.50.

This beautifully illustrated book deals broadly with the field of landscape architecture and takes into account the changes of modern life. The purpose of the book, also, is to contribute to an appreciation of a more enjoyable environment and to assist in the shaping of the physical surroundings of homes, neighborhoods, and communities.

MANUAL OF ENGINEERING DRAWING FOR STUDENTS AND DRAFTSMEN, 6 ed. revised and enlarged. By T. E. French. McGraw-Hill Book Co., New York and London, 1941. 622 pp., illus., diagrs., charts, tables, 9½ × 6 in., cloth, $3.

The new edition of this comprehensive, standard textbook has undergone considerable revision. The page size has been enlarged to allow an increase in the size and number of illustrations; many problems have been changed and added; and in addition to revision of existing chapters new ones have been included on aircraft drawing, jig and fixture drawing, and welding drawing. The material conforms to the standards of the American Standards Association, and there is a useful bibliography of allied subjects.

PARTIAL DIFFERENTIAL EQUATIONS. By F. H. Miller. John Wiley & Sons, New York, 1941. 259 pp., tables, diagrs., 9½ × 6 in., cloth, $3.

The first two chapters of this elementary text are devoted to a review of ordinary differential equation methods, while Chapter III is designed to show the various ways in which partial differential equations come into being. The remaining chapters, with the exception of Chapter VI, which briefly discusses Fourier series, deal with methods of solving different classes of partial differential equations and with geometric and physical problems solvable by the processes explained.

RELAXATION METHODS IN ENGINEERING SCIENCE, a Treatise on Approximate Computation. By R. V. Southwell. Clarendon Press, Oxford, England; Oxford University Press, New York, 1940. 252 pp., diagrs., charts, tables, 9½ × 6 in., cloth, $5.

In this book, a new approach to engineering and physical computations is described—a method which is termed "systematic relaxation of constraints." The greater part of this treatise relates to problems confronted in the theory of elasticity: stress-calculations for frameworks and continuous beams, estimation of critical loads, etc. However, the method is shown to have wider application, and such problems as the adjustment of errors in surveying and the determination of currents and potentials in electrical networks also receive detailed consideration.

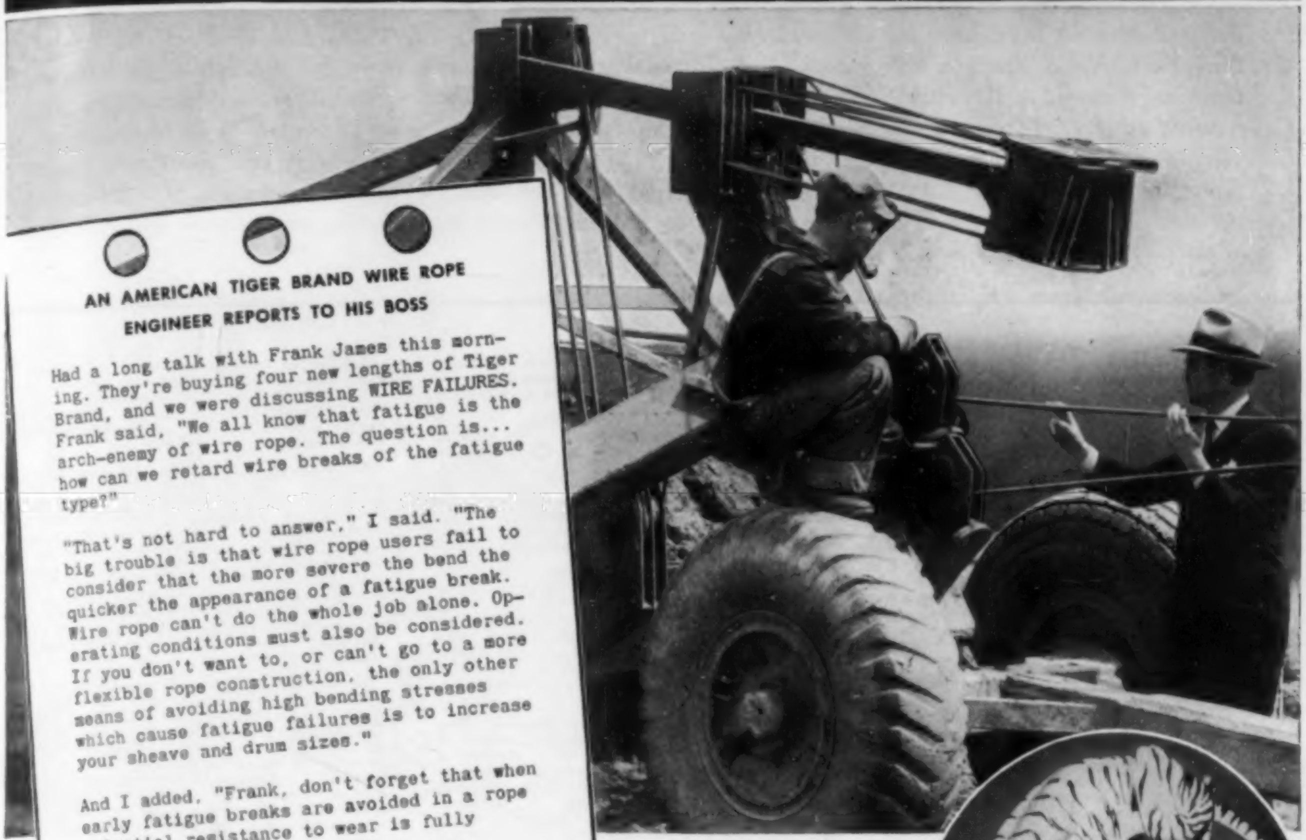
RESEARCH—A NATIONAL RESOURCE. II. Industrial Research. The Government Printing Office, Washington, D.C., 1941. 370 pp., illus., tables, diagrs., charts, 11½ × 9 in., paper, $1.

This report on industrial research in the United States is presented by the National Research Council, at the request of the National Resources Planning Board, as one of a series on research as a national resource. The report discusses the nature, extent, and welfare of industrial research, but does not attempt a catalogue of new wealth coming from the laboratories.

VDI JAHRBUCH 1940, Die Chronik der Technik, herausgegeben im Auftrage des Vereines deutscher Ingenieure im NS.—Bund Deutscher Technik von A. Leitner. VDI-Verlag, Berlin, 1941. 311 pp., 8½ × 6 in., paper, 3.50 rm.

This useful reference work contains some ninety reports by specialists, who review the literature on engineering published during the year 1939. Several thousand references on all branches of engineering are included. An extensive index facilitates the use of the book.

"FATIGUE is the Arch-Enemy of Wire Rope!"



AN AMERICAN TIGER BRAND WIRE ROPE ENGINEER REPORTS TO HIS BOSS

Had a long talk with Frank James this morning. They're buying four new lengths of Tiger Brand, and we were discussing WIRE FAILURES. Frank said, "We all know that fatigue is the arch-enemy of wire rope. The question is... how can we retard wire breaks of the fatigue type?"

"That's not hard to answer," I said. "The big trouble is that wire rope users fail to consider that the more severe the bend the quicker the appearance of a fatigue break. Wire rope can't do the whole job alone. Operating conditions must also be considered. If you don't want to, or can't go to a more flexible rope construction, the only other means of avoiding high bending stresses which cause fatigue failures is to increase your sheave and drum sizes."

And I added, "Frank, don't forget that when early fatigue breaks are avoided in a rope potential resistance to wear is fully realized."

George

Excellay Preformed

NUMEROUS conditions affect wire rope life, but none limits normal efficiency more than severe bending. Wire ropes are manufactured in various constructions for the purpose of securing varying degrees of flexibility. However, increased flexibility is secured at the sacrifice of resistance to abrasion, because greater flexibility is produced by increasing the number of wires in a wire rope which means that the size of the individual wires is correspondingly reduced. In order to secure satisfactory rope life it is necessary to specify a rope construction composed of wires of a large enough diameter so that they will not wear through in a comparatively short time. However, if the sheaves over which the rope operates are not of adequate size, bending stresses will be imposed which will cause wire breaks of a fatigue type and consequent removal of the rope at an early stage, even though the wear is slight. The smaller the size of sheave, the earlier these fatigue breaks will occur and the less the potential resistance to failure from abrasion will be realized.

Give these matters the attention they deserve and replacement of wire rope will be much less frequent. You'll get longer cable life.

Rely on the advice of the American Tiger Brand Wire Rope Engineer. These men can make recommendations which will correct the difficulties you are encountering. They will work with you, without obligation, to help you secure a full dollar's value out of every dollar you invest in wire rope.

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CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Publications (Except Those of the American Society of Civil Engineers) in This Country and Foreign Lands

Selected items for the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own file, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page to members of the Founder Societies (30 cents to all others), plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

CONCRETE ARCH, DESIGN. Standardization of Fixed Arched Bridge Design in Reinforced Concrete, L. E. Hunter. *Structural Engr.*, vol. 19, no. 4, Apr. 1941, pp. 53–59. Review of past attempts to reduce labor of making arch calculations; present-day methods of designing and their drawbacks; modern requirements; method of solving problem.

CONCRETE, CANADA. Long-Span Box-Girder Grade-Separation Bridges for Queen Elizabeth Way Extension, V. S. Murray. *Roads & Bridges*, vol. 79, no. 4, Apr. 1941, pp. 15–17. Design of grade-separation bridges for Queen Elizabeth Way extension east of Toronto, Ontario, featuring spans of 106 ft and longer, hollow-type construction, and use of prefabricated girder reinforcing; comparison of cost; reinforcing frames; tied wing walls.

HIGHWAY, CALIFORNIA. Eel River Bridges, California. *Roads & Streets*, vol. 84, no. 4, Apr. 1941, pp. 74, 76, 78, and 80. Design and construction features of two highway bridges over Eel River, California—North Scotia three-span continuous truss bridge over 800 ft long and Robinson Ferry simple truss bridge consisting of 300-ft spans and 12 concrete girder approach spans; construction of pier foundations; distribution of pier concrete by pumping; cost data.

MILITARY. Developments in Design of Pontoon Bridges, D. E. Swift. *Military Engr.*, vol. 33, no. 189, May-June 1941, pp. 244–249. Principles of modern design and construction of military pontoon bridges; determination of load-carrying capacity; loading and unloading equipment; speed of construction; girder pontoon bridges; specifications for girder sections; arrangements at bridge ends; design of connections.

NATURAL GAS PIPE LINES, RIVER CROSSINGS. Pipe Line Crossing of Swift Watercourses, J. E. Moore. *Petroleum Engr.*, vol. 12, no. 8, May 1941, pp. 85–86 and 88. While referring in general to Western oil and gas fields in semi-arid areas, paper deals specifically with stream crossings and highway crossings and type of suspended span developed by natural gas company operating in Montana and Wyoming; on one job, junked 8-in. pipe was used for supports and supporting cables are from discarded drilling line; suspenders are made of telephone guy wire, with ends "raveled" and wrapped around cable.

PONTOON. Emergency Pontoon Bridge at Hidalgo, Texas, J. W. Beretta. *Military Engr.*, vol. 33, no. 189, May-June 1941, pp. 239–243, (discussion) 243. Details of construction of temporary wooden pontoon bridge at Hidalgo, Tex.; bridge maintenance during floods; bridge performance and costs.

STEEL TRUSS, CALIFORNIA. Design Features of Pit River Bridge. *Eng. News-Rec.*, vol. 126, no. 19, May 8, 1941, pp. 736–740. Design and method of construction of double-deck, highway and railroad bridge across arm of reservoir to be formed by Shasta Dam in California, including concrete piers with record height of more than 350 ft, steel truss superstructure nearly 3,600 ft long; provisions for earthquake stresses.

SUSPENSION, CABLES. Bridge Cables Pre-Stressed, H. H. Gilbert. *Western Construction News*, vol. 16, no. 4, Apr. 1941, p. 108. Methods used in pre-stressing main cables, consisting of eight 3-in. 7/37 wire ropes, for recently completed suspension bridge over Klamath River at Orleans, Calif., having main span of 360 ft.

SUSPENSION, DESIGN. New Type Suspension Bridge Proposed, G. A. Maney. *Eng. News-Rec.*, vol. 126, no. 17, Apr. 24, 1941, pp. 608–609. Comparative tests of models of Tacoma and San Francisco Bay suspension bridges made at Northwestern Technological Institute, Evanston, Ill.; dynamic stability of suspension bridges under various loading conditions; manner in which pre-stressed diagonal hangers, added to conventional cable-vertical hanger-stiffening-truss arrangement, transform flexible cable system into rigid structure defying all efforts to build up vibration amplitude or undulation.

SUSPENSION, FAILURE. Stiffness as Factor in Long Span Suspension Bridge Design, J. H. Cissel. *Roads & Streets*, vol. 84, no. 4, Apr. 1941, pp. 64, 67–68, 70, and 72. Historical review of suspension bridge design and construction since end of eighteenth century, emphasizing suspension bridge failures since beginning of nineteenth century, due to wind or dynamic causes.

SUSPENSION, FAILURE. Tacoma Bridge Report Released by PWA Board of Consultants. *Eng. News-Rec.*, vol. 126, no. 17, Apr. 24, 1941, p. 589. Statement of conclusions of board of engineers appointed to investigate failure of Tacoma Narrows suspension bridge; slippage of center cable band found immediate cause; corrective measures installed, or planned, considered ineffective.

SUSPENSION, FAILURE. Why Tacoma Narrows Bridge Failed. *Eng. News-Rec.*, vol. 126, no. 19, May 8, 1941, pp. 743–747. Review of report on failure of Tacoma Narrows Bridge, by consulting board of Federal Works Administration, stating that: Members of structure showed remarkable strength; towers severely damaged; aerodynamic instability responsible for torsional motions; torsion to which width gives important resistance, is greater danger than is lateral deflection. Comparison with other bridges; elastic properties and comparative deflections of five long suspension bridges.

BUILDINGS

CONSTRUCTION. Old Steel Makes New Building, J. C. Coyle. *Eng. News-Rec.*, vol. 126, no. 19, May 8, 1941, pp. 759–760. Construction of steel frame commercial fireproof building at Yuma, Ariz., by ingenious methods utilizing improvised rigs and steel trusses salvaged from worked-out mine.

CONCRETE

ANTI-AIRCRAFT PROTECTION, SHELTERS. Precast Concrete for Bomb Shelters in Quick Time, O. A. Aisher. *Concrete*, vol. 49, no. 4, Apr. 1941, pp. 4–6. Author tells of success attained by his company individually, and by pre-cast concrete industry collectively, in development of pre-cast concrete units that permit rapid erection of effective bomb shelters throughout England; several diagrams showing shelter construction approved by government are presented.

CURING. Calcium Chloride in Concrete Production, R. W. Miller. *Constructor*, vol. 23, no. 4, Apr. 1941, pp. 26–28. Review of experimental studies of admixture method of concrete curing with calcium chloride; effects of calcium chloride on portland cement concretes; use of calcium chloride in concrete curing; advantages of calcium chloride curing to contractor.

FLOORS. Integrally Colored Concrete Floors—Sensible Job Practice, R. L. Peck. *Concrete*, vol. 49, no. 4, Apr. 1941, pp. 13–14. Author sums up what constitutes good colored concrete floor, showing that it is really only matter of proper design, good material, correct equipment, and careful installation; details of procedure described; points to watch are listed. Before Am. Concrete-Contractors' Assn.

PLASTICITY. Plastic Flow of Concrete Declared to Be Non-Existent, G. A. Maney. *Concrete*, vol. 49, no. 4, Apr. 1941, pp. 33–34. Experimental evidence to substantiate belief that so-called "plastic flow" of concrete is non-existent. From Bulletin entitled "Studies in Engineering—No. 1," issued by Northwestern Technological Institute.

PRE-CAST. Pre-Cast Concrete on Public Works in India. *Concrete & Constr. Eng.*, vol. 36, no. 2, Feb. 1941, pp. 63–69. Abstract of article published in *Indian Concrete J.*, of August 15, 1940, describing use of pre-cast concrete facing blocks and roof units for sluice barrage, 3,025 ft long, constructed below junction of Chenab and Jhelum rivers; details of pre-cast concrete blocks and troughs.

RESERVOIRS. New Type Reservoir at Syracuse, N.Y. *Am. Water Works Assn.—J.*, vol. 33, no. 5, May 1941, pp. 861–875. Design and construction of Morningside Reservoir for water works of Syracuse, N.Y., consisting of three circular units located immediately adjacent to each other; center unit is 171 ft in diameter and smaller units flanking it on either side are 111 ft in diameter; total height of structure is 34 ft, of which 10 ft is below ground; erection of tanks; mesh reinforcement; application and curing of gunite; automatic control features; landscaping of grounds.

WAREHOUSES. Large Concrete Warehouses Built with Moving Falsework. *Eng. News-Rec.*, vol. 126, no. 17, Apr. 24, 1941, pp. 596–599. Design and construction of three 182 by 1,562-ft warehouses for Columbus General Depot of U.S. Army being built with reinforced concrete frames, thin barrel roofs of same material, and brick walls; roof slabs and supporting girders constructed on trussed timber forms that can be rolled ahead as work progresses; contractor's cycle of operations; arch concreting.

HYDRAULIC ENGINEERING

HYDRODYNAMICS. Description of Water Tunnel and Apparatus for Investigation of Flow Problems, A. Fage and J. H. Preston. *Roy. Aeronautical Soc.—J.*, vol. 45, no. 364, Apr. 1941, pp. 124–140. Water tunnel, closed-return type, described is especially suitable for observation of flow near surface of long streamline body of revolution at Reynolds numbers up to 1.3×10^6; tunnel is equipped with two instruments designed for flow observation, fluid-motion microscope, and fluid-motion microscope with interrupter.

HYDROLOGY AND METEOROLOGY

BUILDINGS, EARTHQUAKE RESISTANCE. Effect of Earthquakes on Framed Buildings, A. J. Ockleston. *Instn. Civ. Engrs.—J.*, vol. 16, no. 5, Mar. 1941, pp. 41–64. Nature of earthquake motion; behavior of buildings during earthquakes; lateral vibration of building frames; vibration of model of building frame; effect of earthquakes on building frames. Bibliography.

HYDROLOGY, BIBLIOGRAPHY. Bibliography of Hydrology United States of America for Year 1939. Washington, D.C., *Am. Geophysical Union—Sec. Hydrology 1940*, 86 pp. Covers published material on hydrometeorology, water courses, lakes, glaciers, underground water and springs, balance of hydrologic cycle, application of various sciences to hydrology, and general works.

RAIN AND RAINFALL, INTENSITY. Prediction of Maximum Rainfall Intensity Equation, J. F. McIllwraith. *Commonwealth Engr.*, vol. 28, no. 5, Dec. 2, 1940, pp. 148–156. Discussion of theory underlying estimation of maximum rainfall, with special reference to conditions obtaining in Australia; causes of precipitation; table of rainfall intensities from Weather Bureau gaging-station records; excessively high intensity storms. Bibliography.

STRUCTURES, EARTHQUAKE EFFECT. Procedimiento aproximado para la determinacion de la accion de los temblores en las construcciones, H. del Canto, E. Aguirre, and J. Ibanez V. *Instituto de Ingenieros de Chile—Anales*, vol. 54, nos. 1 and 2, Jan. 1941, pp. 12–14, and Feb., pp. 74–91. Approximate procedure for determination of action of earthquakes on structures; discussion of static method; explanation of physical basis of simplified procedure; example; study of concrete bridge pier; notes on period of destructive seismic waves; vibration period of structural types.

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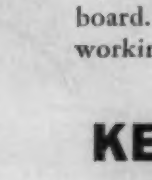

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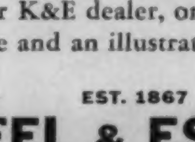
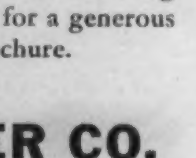
Perspiration and water splashes on ordinary tracing cloth create "ghosts" which reproduce on blueprints. PHOENIX Tracing Cloth withstands actual immersion in water for fully 10 minutes at a time! *Perspiration and water marks will not stain it!*



PHOENIX LESSENS SMUDGE GHOSTS

The new improved surface of PHOENIX Tracing Cloth permits you to use harder pencils (5H and 6H) and to get sharper lines with less tendency to smudge.

Result: Cleaner tracings and blueprints.



PHOENIX REDUCES ERASURE GHOSTS

Ordinary tracing cloths become scarred when erased... erased spots produce ghosts on blueprints.

PHOENIX has a durable drawing surface that reduces working scars to a minimum.

WATERSHEDS, SURFACE TREATMENT. Bituminous Surfacing Treatment of Portion of Water Supply Catchment at Narrogin, Western Australia, J. W. Young. *Instn. Engrs. Australia—J.*, vol. 13, no. 2, Feb. 1941, pp. 52–54. Methods used in construction of bituminous lining over 50 acres of watershed area in very arid district in western Australia in order to increase its water yield; selection of area to be treated; construction of drains; cost data.

INLAND WATERWAYS

RIVERS, SILT. Sand Waves in Lower Mississippi River, E. W. Lane and E. W. Eden. *Western Soc. Engrs.—J.*, vol. 45, no. 6, Dec. 1940, pp. 281–291. Review of observations on movement of bed load sand in Lower Mississippi River; rate of motion of sand waves; size of material in Mississippi River sand waves; height of crest of sand waves and distance apart; dimensions of sand waves at Lake Providence, La.; comparison of observations; quantity of material moved; chronological record of bottom elevation at Vicksburg Bridge, Vicksburg, Miss.

IRRIGATION

CANALS, ARIZONA. Storm Drainage Structures, Gila Gravity Main Canal, W. W. Brenner. *Reclamation Era*, vol. 31, no. 2, Feb. 1941, pp. 35–36. Description of several automatic spillways, wasteways, and overchute for disposal of storm-waters of creeks and washers crossing line of Gila Gravity Main Canal, 20.9 miles long, constructed to carry Colorado River water from Imperial Dam to edge of mesa lands and Gila River bottom lands east of Yuma, Ariz.

COLORADO RIVER WATER. Use of Softened Colorado River Water for Home Gardens, O. C. Magistad. *Am. Water Works Assn.—J.*, vol. 33, no. 5, May 1941, pp. 883–893. Use of treated Colorado River water on lawns, gardens, and shrubbery of home owners in Metropolitan Water District of Southern California; effect of prolonged irrigation with saline water; principal soil types and areas in Los Angeles and Pasadena District; effect of irrigation on Los Angeles soils. Bibliography.

UTAH. Completion of Moon Lake Project, R. H. Madsen. *Reclamation Era*, vol. 31, no. 2, Feb. 1941, pp. 33–34 and 50. Description of Moon Lake project in northeastern Utah, including earth-fill dam 110 ft high, irrigation canal 15 miles long, also various dikes, lateral, etc.

LAND RECLAMATION AND DRAINAGE

CULVERTS, CONSTRUCTION. Floating 150-In. Multiplate Culvert Back Into Place. *Roads & Streets*, vol. 84, no. 4, Apr. 1941, pp. 52 and 54. Methods used in installing and backfilling 150-in. multi-plate culvert on Federal Aid Project 127-B, Diversion Dam—Dubois Highway in Fremont County, Wyoming, which floated out of position due to floods during construction.

MOSQUITO CONTROL. Anti-Malaria Drainage, J. E. Bach. *Eng. Assn. Malaya—J.*, vol. 8, no. 2, Aug. 1940, pp. 83–104. Review of Malayan experience in drainage for mosquito control since 1910, including descriptions of specific projects and their effect on health; shade protection and other methods of mosquito control.

MATERIALS TESTING

DAMS, EARTH. Prelude to Dynamite, A. R. Boone. *Explosives Engr.*, vol. 19, no. 2, Feb. 1941, pp. 39–43. Discussion of methods and equipment developed by U.S. Army Engineers for testing soils and other fill materials for construction of earth and rock dam.

FRAMED STRUCTURES, STEEL. Plastic Theory—Its Application to Design, J. F. Baker and J. W. Roderick. *North-East Coast Instn. Engrs. & Shipbldrs.—Paper*, Mtg. Apr. 25, 1941, 28 pp., 2 supp. plates. With view of eventually producing more rational methods of design for steel frame structures with fixed connections, model beams and frames have been tested to determine their true strength; results given; it is shown that beam, restrained at its ends, is able to carry more load before collapse takes place than is so in simply supported condition.

RESEARCH LABORATORIES. Reclamation Laboratory—Tool of Scientific Engineering. *Reclamation Era*, vol. 31, no. 2, Feb. 1941, pp. 29–23. Discussion of functions and activities of U.S. Bureau of Reclamation Laboratory of Denver, Colo., divided into six operating units as follows: Hydraulic structures, hydraulic machinery; earth materials; aggregates, concrete, and metals; cements and miscellaneous materials; and shops, equipment, and supplies.

MUNICIPAL ENGINEERING

GREAT BRITAIN. Municipal Engineering in 1940. *Surveyor*, vol. 99, no. 2558, Jan. 31, 1941, pp. 57–80. Review of 1940 progress in British municipal engineering presented under following headings: Roads and bridges; water supply; sewerage and sewage disposal; refuse collection and disposal; housing; town and country planning; municipal vehicles; air raid precautions. Bibliography.

PORTS AND MARITIME STRUCTURES

CARDENAS, CUBA. Port of Cardenas, Cuba Marine Terminal. *World Ports*, vol. 3, no. 2, Nov. 1940, pp. 10–11 and 31. Operations of Port of Cardenas; notes on pier 1,000 ft long, 250 ft wide, and 24 ft deep, under construction for Compania de Construcciones Maritimas, S.A., at Cardenas, Cuba, by Standard Dredging Corp.

CARGO HANDLING. Handle Less—Profit More, S. R. Dubrowin. *Mar. News*, vol. 27, no. 11, Apr. 1941, pp. 47–48 and 49–52. Suggestions given as to how modern material-handling methods can help cut costs at piers; types of equipment used for handling cargo.

LOS ANGELES. Depth Changes in Dredged Channels, H. Leypoldt. *World Ports*, vol. 3, no. 7, Apr. 1941, pp. 12–14 and 23. In view of fact that Los Angeles Harbor consists of group of dredged channels, basins, and slips, created practically in entirety from expanse of mud flats and shallow, winding channels, résumé of ways in which attained dredged depths are subject to change is given; dredging done by hydraulic suction dredging with pipe line disposal, or bucket dredging with disposal behind bulkheads or barging to sea; material dredged was chiefly clay, sand, shells, and silt.

NEW YORK CITY. Port of New York Carries on, F. C. Ferguson. *World Ports*, vol. 3, no. 1, Oct. 1940, pp. 6–7. Use of Port of New York during period of emergency; to date traffic has increased by more than 100% over same months in 1939; port facilities; expansion of physical facilities during past 20 years; harbor equipment utilized for swift movement of cargo to and from different sections of district increased and modernized.

ROADS AND STREETS

AIRPORT RUNWAYS. Asphalt-Stone Construction for Airport Surfaces, A. H. Hinkle. *Crushed Stone J.*, vol. 16, no. 2, Mar.-Apr. 1941, pp. 9–12 and 17–18. Advantages of asphalt stone mixtures in attaining smooth surface, strength, and durability, non-skid surfaces, freedom from loose particles, and speed and ease of repair. Before Nat. Crushed Stone Assn.

ASPHALT. Selecting Asphaltic Surface Types, L. F. Rader. *Better Roads*, vol. 11, no. 3, Mar. 1941, pp. 27–28, 37–38, and 40. Discussion of factors governing service requirements comparing asphaltic surface types applicable under similar conditions; suitability of aggregates; surface characteristics; road mix vs. plant mix; cold vs. hot plant mix; penetration macadam vs. plant mix; current tendencies.

BETHLEHEM, PA. Low-Cost Improvement of City's Dirt Streets, G. H. Reussner. *Am. City*, vol. 56, no. 5, May 1941, pp. 67 and 69. Comparative study of methods on complete improvement of dirt streets of Bethlehem, Pa.; preparing base; cost of road oiling; wearing surface; cost of street surfacing.

BITUMINOUS. High-Type Non-Rigid Pavement, E. B. Lockridge. *Better Roads*, vol. 11, no. 5, May 1941, pp. 26 and 31–33. Review of practice of Indiana State Highway Commission in construction of wearing surfaces of bituminous concrete and rock asphalt over courses of penetration and waterbound macadam.

BITUMINOUS. Paving Army's Streets. *Western Construction News*, vol. 16, no. 5, May 1941, pp. 136–138. Methods and equipment used in construction of bituminous macadam surfacing $2^1/_2$ in. thick on 5 in. of crusher run base for principal streets at Fort Ord, Calif., also 250,000 sq yd of truck-parking areas.

BRICK. New Separating Agent and Applier to Prevent Surface Adhesion of Asphalt Filter to Brick Pavements, H. Z. Schofield. *Roads & Bridges*, vol. 79, no. 4, Apr. 1941, pp. 25 and 52. Description of surface removal method in brick pavement construction whereby spaces between bricks are filled by flooding newly laid brick course with molten asphalt and then searing and peeling away asphalt surface; procedure is made possible by "separating agent" which, when applied to brick tops prior to flooding, prevents adhesion of asphalt.

CHICAGO, ILL. West Route of Chicago's Comprehensive Superhighway System, C. E. De-Leuw. *Western Soc. Engrs.—J.*, vol. 46, no. 1, Feb. 1941, pp. 30–42. Discussion of Chicago City Council recommendations for comprehensive superhighway plan; fundamental principles of superhighway design; available superhighway types; comparison of alternate types; turn-outs; studies leading to recommendation of Congress street plan; estimate of alternate types and locations; approved plan.

CONCRETE. Cotton Quilts for Curing Concrete Paving. *Roads & Streets*, vol. 84, no. 5, May 1941, pp. 41–43. Survey of curing methods showing what state specifications permit; quilt sizes; costs.

CONCRETE. Progress in Experiments with Continuous Reinforcement in Concrete Pavements, H. D. Cashell and S. W. Benham. *Pub. Roads*, vol. 22, no. 3, May 1941, pp. 49–58 and 65. Study of data obtained during first two years of observations of continuously reinforced concrete pavement sections; changes in pavement elevation; annual cycle of length change; cracks developed in central areas; relative roughness determinations.

CONSTRUCTION. Four Lane Road Built Without Detour, G. H. Ehringer. *Roads & Streets*, vol. 84, no. 5, May 1941, pp. 46–48 and 52. Report on reconstruction—by widening existing 18-ft pavement to 40-ft pavement—of section of route U.S. 29 between Salisbury and China Grove, N.C., 6.83 miles long; grading; concrete paving; asphalt paving.

CONSTRUCTION. Reduction of Cost of Road Construction, C. M. Baskin. *Roads & Bridges*, vol. 79, no. 5, May 1941, pp. 30, 70, 72–73, and 75. Discussion of scarcity of standards in highway construction; effects of private enterprise; roads as decentralizing agent; why bearing capacity of roads fluctuates with season of year; character of soils; measure of bearing capacity; soil data applied to bases; mechanical stabilization. Before Eng. Inst. Canada.

CURVES. Reverse Curves on Highways, H. Criswell. *Roads & Road Construction*, vol. 18, no. 216, Dec. 2, 1940, pp. 222–223, and (discussion) vol. 19, no. 217, Jan. 1941, pp. 16–17. Outline of method of inserting transition curves between two circular curves of opposite direction, connected by short tangent, circular arcs being considered as fixed; numerical examples.

EMBANKMENTS, STABILIZATION. Stability of Clay Slopes, R. R. Minikin. *Civ. Eng.* (London), vol. 35, no. 413, Nov. 1940, pp. 320–322. Theoretical mathematical discussion of cylindrical shear method of dealing with earth slopes known as "Swedish" method—that is, essentially simple mechanical analysis of system of forces operating upon clayey ground subjected to uneven loading.

EXCAVATING MACHINERY. Some Economic Factors Relating to Earthwork Machinery, A. H. D. Markwick. *Roads & Road Construction*, vol. 19, no. 217, Jan. 1, 1941, pp. 5–8. General discussion of economic factors; application of mechanical power to excavation; classification of earthwork machinery and operations; importance of haulage costs; influence of length of haul upon efficiency of various types of plant; costs of operation; reliability and maintenance; technical factors in earthwork construction; choice of plant. Bibliography.

GUARD RAILS. Spring-Steel Brackets for Timber Guardrail, J. N. Bishop and I. A. DeFrance. *Eng. News-Rec.*, vol. 126, no. 17, Apr. 24, 1941, pp. 606–607. Description and results of impact tests of Oregon guard-rail design in which timber rails and posts are connected by spring-steel mounting; specifications for spring-steel; dimensions and arrangement of rail, spring-steel mounting, and posts.

HIGHWAY ENGINEERING, STANDARDS. California Revises Its Standard Specifications for Highway and Bridge Work. *Western Construction News*, vol. 16, no. 4, Apr. 1941, pp. 114–117. Part III of comprehensive review of changes appearing in sixth edition of California Division of Highways Standard Specifications; painting and waterproofing; rubble masonry; guard rails and fences; portland cement concrete; reinforcement for concrete; old and new classifications of liquid asphalts.

HIGHWAY SYSTEMS, CANADA. Trans-Canada Highway, W. R. Jeffreys. *Roads & Road Construction*, vol. 19, no. 219, Mar. 1, 1941, pp. 40–42. Features of Trans-Canada highway described in several previously indexed articles.

HIGHWAY SYSTEMS, PAN-AMERICAN. Great Highway of Americas. *Better Roads*, vol. 11, no. 3, Mar. 1941, pp. 17–19. General discussion of value of Pan-American Highway; completion status of Pan-American Highway.

INDIA. Trackways, K. G. Mitchell. *Roads & Road Construction*, vol. 19, no. 219, Mar. 1, 1941, pp. 46–48. Discussion of Indian practice of construction of trackways of cement concrete or other durable material which can be used to take main wear and tear of cart traffic, either on earth road or inlaid into road surface of kankar, laterite, or other material which will bind along joints with trackway; use of trackways on earth roads; cost data.

PARAGUAY. Road Construction in Paraguay, H. W. Durham. *Eng. News-Rec.*, vol. 126, no. 23, June 5, 1941, pp. 65–67. Report on organization and operations for construction of modern highway 185 km long from Asuncion to Villarrica, Paraguay.

PARKS. New Road Construction in Western National Parks, J. A. Bell. *Landscape Architecture*, vol. 31, no. 2, Jan. 1941, pp. 63–67. Notes on building of roads in scenic areas.

ROAD MATERIALS, ASPHALT. Recent Asphalt Research Improvements in Paving Technique, R. W. Parkhurst. *Commonwealth Engr.*, vol. 28, nos. 5 and 6, Dec. 2, 1940, pp. 141–145, and Jan. 1, 1941, pp. 188–192. Review of progress in testing and use of asphalt road pavements; physical testing of pavement serviceability; resistance to cracking; recent studies in technology of bitumens; compression testing applicable to asphaltic mixtures; compression tests correlated with service results; significance of bitumen type in asphaltic mixtures; softness of bitumen. Bibliography.

RURAL. Life Characteristics of Surfaces Constructed on Primary Rural Highways, R. Winfrey and F. B. Farrell. *Pub. Roads*, vol. 22, no. 1,

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MODERN construction projects should be protected against the menace of timber decay and natural deterioration. AmCreCo pressure treated piles, poles and timber give that protection with the additional advantage of economy, found in low first cost, reduced maintenance expense and long life. AmCreCo creosoted products have maintained their same high standard of quality for over thirty five years. They are today, as in the past, made of sound timber, treated with only time tested and proven preservatives. The reputation of AmCreCo pressure treated piles, poles and timber will always be guarded by this same strict policy. Their use is a definite guarantee of satisfaction. Information will be sent upon request.
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Mar. 1941, pp. 1–24. Life characteristics of various surface types constructed on primary rural highways determined from analysis of construction and retirement mileage data obtained by several states in connection with road-life study phase of state-wide highway-planning surveys; estimates of average service lives; retirement of road surfaces.

SOILS, STABILIZATION. Soil Research in India. *Roads & Road Construction*, vol. 18, no. 216, Dec. 2, 1940, pp. 225–226. Report on soil research being carried out at Irrigation Research Institute, Lahore, India; ultra-mechanical analysis of soils; stabilization of soil with lime and molasses; prevention of salt movement by presence of insulating layer of sand.

STABILIZATION. Asphaltic Base Stabilization in Large Kansas County, O. C. Carlson. *Better Roads*, vol. 11, no. 5, May 1941, pp. 17–18. Discussion of practice of Sedgwick County, Kansas, in construction of stabilized bases in dune sand region using medium curing cutback.

SEWERAGE AND SEWAGE DISPOSAL

ACTIVATED SLUDGE. Dissolved Oxygen and B. O. D. Determinations. Their Application and Interpretation, C. C. Ruchhoft. *Sewage Works J.*, vol. 13, no. 3, May 1941, pp. 542–550. Discussion of methods of dissolved oxygen determination for activated sludge plant control, for stream pollution studies and for biochemical-oxygen-demand studies; dissolved oxygen in river waters; interpretation of results of oxygen-demand test; B. O. D. decrease in streams. Bibliography.

ACTIVATED SLUDGE. Operation of Activated Sludge Plant, D. B. Bloodgood. *Wisconsin Engr.*, vol. 45, no. 6, Mar. 1941, pp. 4–5. Step-by-step procedure at plant using activated-sludge process of biological sewage disposal.

AIRPORTS, SANITATION. Sewage Treatment for Airports. *Pub. Works*, vol. 72, no. 3, Mar. 1941, pp. 11–13, 40, 42, and 44–45. Plans and specifications for several types of sewage treatment plants for typical airport of about 2,500 population; sedimentation tanks; digestion tanks; low-rate trickling filters; bio-filter plants; aero-filtration plants; activated sludge plant.

ANALYSIS. Hydrogen Sulfide in Sewage, R. Pomeroy. *Sewage Works J.*, vol. 13, no. 3, May 1941, pp. 498–505. Review of studies of methods of determining concentration of un-ionized hydrogen sulfide in sewage or water; hydrogen sulfide factors; determination of sulfides in sewage and in sewer atmospheres; preparation of permanent standards. Bibliography.

DISPOSAL PLANTS, AUSTRALIA. Melbourne New Sewerage Plant Serves S.E. Area, E. F. Borrie. *Commonwealth Engr.*, vol. 28, no. 6, Jan. 1, 1941, pp. 173–180. Description of sewerage system and new Braeside treatment plant designed to treat flow of 500,000 gal per day from population of 16,700 persons; trickling filters; disposal of plant effluent for irrigation; flow and temperature measurements; cost data.

DISPOSAL PLANTS, BAKERSFIELD, CALIF. Combining Old and New in Sewage Disposal. *Eng. News-Rec.*, vol. 126, no. 21, May 22, 1941, pp. 811–812. Description of new 7.5-mgd sewage disposal plant of Bakersfield, Calif., featuring recently developed combination flocculator-clarifier unit, which gives high efficiency in removal of suspended solids; use of effluent to irrigate 600 acres of pasture land.

DISPOSAL PLANTS, MARYLAND. Sludge Disposal Dominates Plant Design, H. R. Hall. *Eng. News-Rec.*, vol. 126, no. 19, May 8, 1941, pp. 748–750. Design and operation of new 7.5-mgd sewage disposal plant for Washington Suburban Sanitary District; sludge processing facilities; elutriation of sludge; sludge filtration; grease flotation tank; total cost about $800,000.

DISPOSAL PLANTS, NEW JERSEY. Combination Chemical-Biological Sewage Treatment Plant, A. B. Kozma. *Water Works & Sewerage*, vol. 88, no. 4, Apr. 1941, pp. 141–152. Design, construction, and equipment of 4-mgd sewage disposal plant serving Rutherford, East Rutherford, and Carlstadt, N.J., combining chemical, mechanical, and biological treatment in highly flexible manner; cost of project $903,890; operating costs; centralized control; laboratory and operating results.

DISPOSAL PLANTS, SLIDE RULES. Slide Rule for Sewage Plant Operators. *Water Works & Sewerage*, vol. 88, no. 4, Apr. 1941, p. 188. Description of special slide rule for computing percentage of solids removed by sedimentation tanks, also chlorine dosage from daily pumpage and amount fed.

DISPOSAL PLANTS, WASTE UTILIZATION. Concerning Those Plus Fertility Values of Sewage Sludges, A. M. Rawn. *Water Works & Sewerage*, vol. 88, no. 4, Apr. 1941, pp. 186–188. Discussion of extra-fertilizing value of sewage sludge based on 13 years of California's experience; discussion of previously indexed article by W. Rudolfs from issue of December 1940.

INDUSTRIAL WASTE. Treating Milk Wastes by Two-Stage Filtration, E. F. Wittmer. *Pub. Works*, vol. 72, no. 3, Mar. 1941, pp. 19–20 and 37–38. Report on procedure of changing old Imhoff contact bed-sand filter plant of Maysville, Ohio, to settling tank-trickling filter-sand filter type and success of latter in handling milk wastes.

SLUDGE. Comparative Digestibility of Scum and Sediment Obtained from Primary Tank Sludge, C. E. Keefer. *Sewage Works J.*, vol. 13, no. 3, May 1941, pp. 492–497. Report on experimental study, by Bureau of Sewers of Baltimore, Md., on relative speed of digestion of scum and sediment; total gas production from scum and sediment; CH_4 production from scum and sediment; ratio of gas from scum to gas from all sludge; percentage of CH_4 in gas from scum and from sediment.

SLUDGE. Experimental Digestion, G. J. Wiest. *Water Works & Sewerage*, vol. 88, no. 5, May 1941, pp. 235–239. Study of efficacy of activated carbon on digester behavior and sludge quality at Lancaster, Pa.; rates of sludge drying with alum and with activated carbon, on experimental and plant scale. Bibliography.

STRUCTURAL ENGINEERING

ANTI-AIRCRAFT PROTECTION, INDUSTRIAL PLANTS. Single Storey Wartime Factory Design, J. F. Baker. *Instn. Civ. Engrs.—J.*, vol. 16, no. 5, Mar. 1941, pp. 73–79. Reprint of Bulletin C 12 published by Ministry of Home Security, Great Britain, Research and Experiments Department, discussing principles of design of single-storey industrial buildings exposed to aerial bombing; effect of various roof coverings, including 4-in. reinforced concrete slabs.

ANTI-AIRCRAFT PROTECTION, ROOFS. Flat Roofs and Air Attack. *Water & Water Eng.*, vol. 43, no. 538, Apr. 1941, pp. 122–123. Conversion of existing flat asphalt roofs into miniature reservoirs to safeguard against fire in event of air attack.

ANTI-AIRCRAFT PROTECTION, SHELTERS. Column Analogy Applied to Design of Shelters, E. Shepley and N. R. Tembe. *Concrete & Constr. Eng.*, vol. 36, no. 4, Apr. 1941, pp. 155–171. Theoretical mathematical discussion of application of Hardy Cross column analogy method to design of rigid concrete air-raid shelters; numerical examples; design charts.

BEAMS, CONCRETE. Alignment Charts for Reinforced Concrete Beams, F. K. Hosking. *Commonwealth Engr.*, vol. 28, no. 7, Feb. 1, 1941, pp. 208–209. Construction of alinement chart for computing stresses in rectangular reinforced concrete beams.

BEAMS, CONTINUOUS. Continuous Beams and Rigid Frames, A. Fruchtlander. *Concrete & Constr. Eng.*, vol. 36, no. 4, Apr. 1941, pp. 182–187. Examples demonstrating usefulness of algebraic method of design of continuous beams and rigid frames. (Concluded.)

BEAMS, STEEL. Design of Beams in Steel Frame Buildings, S. D. Lash. *Eng. J.*, vol. 24, no. 4, Apr. 1941, pp. 188–195. Theoretical mathematical discussion of methods for design of beams in steel frame buildings in which allowance is made for partial or complete restraint of ends; secondary beams; beams connected to columns; design of girders having rigid connections; semi-rigid connections; curves showing relation between allowable restraint and fixed-end moment; effect of concrete encasement; numerical examples. Bibliography.

CHIMNEYS, DESIGN. Selecting Chimney Size for Natural Draft, J. G. Mingle. *Power*, vol. 85, no. 3, Apr. 1941, pp. 114, 116, and 118. Practical discussion pointing out that logical procedure is to design chimney to produce required draft when discharging maximum weight of gases to be handled at probable stack temperature.

FRAMED STRUCTURES, STRESS ANALYSIS. Axial Deformation Determined by Moment Distribution, A. Floris. *Western Soc. Engrs.—J.*, vol. 46, no. 1, Feb. 1941, pp. 42–48. Theoretical mathematical discussion of extension of moment-distribution method to cover axial deformation of rigid frames, illustrated by means of numerical examples; uniformly distributed symmetrical loading; lateral concentrated loading; unsymmetrical vertical loading.

JOINTS, WOODEN. Design of Joints in Timber Structures, R. F. Turner. *Commonwealth Engr.*, vol. 28, no. 9, Apr. 1, 1941, pp. 268–269. Presentation of graphical chart for design of wooden joints based upon Hankinson's formula.

POLES, DESIGN. Notes on Determining Stresses in Guys of Guy-Supported Masts, H. Tooley. *Instn. Civ. Engrs.—J.*, vol. 15, no. 3, Jan. 1941, pp. 220–221. Abstract of paper presenting diagram by which stresses in guys and movements of mast can be easily determined.

RIVETED JOINTS, STRESSES. Stresses in Riveted Joints, J. D. W. Ball. *Engineer*, vol. 171, no. 4439, Feb. 7, 1941, pp. 100–101. Reproduction given of one of gusset plates of central joint in cantilever arm of long-span bridge truss, designed in high tensile steel; stresses at various sections of plate, determined by locating corresponding fraction of total forces at each rivet hole, are recorded in tables and diagrams; it is indicated that very complete analysis of stresses in joints is necessary if maximum values are not to be overlooked.

ROOFS, ARCH. Barrel Shell Roof for Ice Arena, R. L. Bertin. *Eng. News-Rec.*, vol. 126, no. 21, May 22, 1941, pp. 804–807. Use of movable truss assembly traveling on timber trestles, to carry form used in concreting 132-ft span of barrel-arch shell roof of Uline Arena in Washington, D.C., providing ice rink 88 by 218 ft with spectator seating capacity of 5,064; roof design; design of trestles and arch form; concrete mixing and curing.

ROOFS, ARCH. Small Arched Roofs, W. S. Gray. *Concrete & Constr. Eng.*, vol. 36, no. 5, May 1941, pp. 193–203. Report on part of investigation to find solution of problem of constructing living quarters for troops without using constructional steelwork or reinforced concrete; construction without centering; constructing arch or dome without centering; formulas for design; arches actually constructed; test of tied arch.

STEEL STRUCTURES, JOINTS. New Joining Method for Structural Sections. *Steel*, vol. 108, no. 21, May 26, 1941, pp. 68 and 70. Structural sections are prefabricated from standard rolled shapes such as L, T, and I sections; ends of members have ingenious key and lock connection die cut into them, no machining being required; method offers important possibilities for cantonments, camps, scaffoldings, and all types of temporary structures as well as houses, storage buildings, and others.

STRUCTURAL DESIGN, BRACING. Bracing—When and How Much? H. S. Woodward. *Eng. News-Rec.*, vol. 126, no. 21, May 22, 1941, p. 818. Discussion of basic recommendations for design and use of bracing; bracing effect of floor arches, steel girders, and wood joists; knee-angle bracing of top flange.

STRUCTURAL DESIGN. Methods of Structural Analysis in Case of Creep, J. Marin. *Western Soc. Engrs.—J.*, vol. 45, no. 6, Dec. 1940, pp. 301–312. Discussion of methods of stress analysis for cases of creep in structural members which are both statically determinate and indeterminate; creep stress law; influence of creep in modifying values of statically indeterminate stresses; relation between creep rate and stress; energy methods of analysis; slope deflection method; moment distribution method; comparison of experimental and theoretical results; working stresses for design of structural members.

STRUCTURAL DESIGN. Justification and Control of Limit Design Method, F. P. Shearwood. *Eng. J.*, vol. 24, no. 6, June 1941, pp. 284–290. Outline of theory of limit design making reasonable use of ductile yield of steel in designing; typical illustrations of effect of yield on strength of steel frames.

WALLS, MASONRY. How Types of Joints Create Variety in Appearance of Concrete Masonry Walls, H. J. Vincent. *Concrete*, vol. 49, no. 5, May 1941, pp. 10–11. Use of different kinds of joints to obtain variety in appearance of concrete masonry walls comprises broad subject; five commonly used methods discussed as follows: square tooled, V-tooled, round tooled, raked joint, and trowel-cut flush.

WINDOWS. Window Design and Selection, R. Allwork. *Arch. Rec.*, vol. 89, no. 5, May 1941, pp. 81–88. Review of present trends in design and manufacture of windows; specifications for metal frames and sash and for wood frames and sash.

SURVEYING

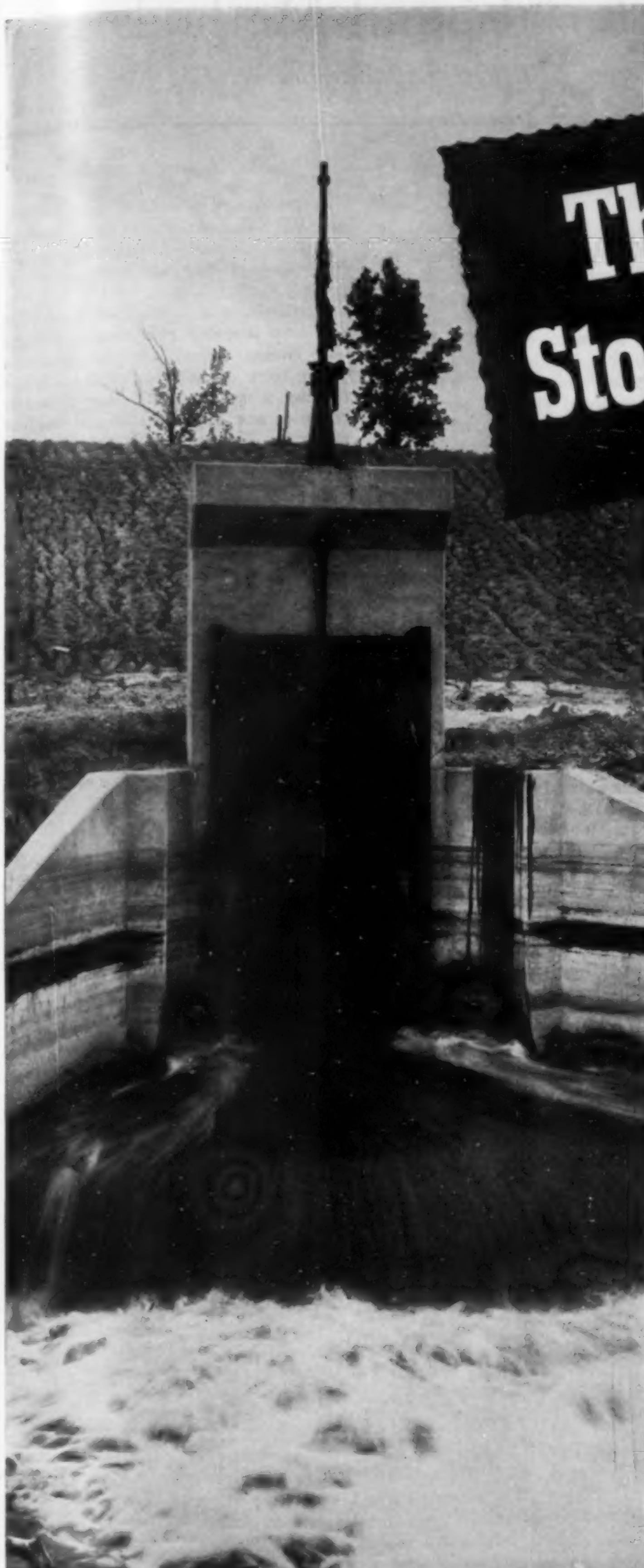
HYDROGRAPHIC SURVEYING, BELGIAN CONGO. Etudes hydrographiques relatives au Congo Belge, R. Spronck. *Revue Universelle des Mines*, vol. 16, no. 8/9, Aug./Sept. 1940, pp. 213–217. Hydrographic studies of Belgian Congo; Review of two recent works: One is report by E. Devroey and R. Vanderlinden on Lower Congo; other is work by E. Devroey on Kasai and its hydrographic basin.

ROADS AND STREETS. How Ontario Highways Department Uses Aerial Photos for Surveying and Mapping, W. J. Fulton. *Roads & Bridges*, vol. 79, no. 4, Apr. 1941, pp. 18–21, 54, and 56. Aerial survey photographs used by Ontario Department of Highways for reconnaissance, exploration, and location surveys in field, and for production of maps; interpretation of photographs; determination of scale; orientation; field use of stereoscopic methods; studying photos in field; airport maps; machine for map tracing.

ROADS AND STREETS, CURVES. Method of Computing Intersection of Line with Spiral and Any Curves Parallel to Spiral, M. C. Koehler. *Pub. Roads*, vol. 22, no. 3, May 1941, pp. 63–64. Presentation of practically exact method of computing protection of line spiral or easement curves used in modern highway construction; numerical examples.

TRAFFIC CONTROL

SIGNALS AND MARKINGS. Center-Striping Missouri Highways, L. W. Corder. *Better Roads*, vol. 11, no. 3, Mar. 1941, pp. 33–36. Study of equipment used for striping; types of paint used; analysis of Missouri 1939 striping costs; future developments.



These Gates Stop Backflow!

High water will never flood your property when Calco-Hardesty Gates stand guard. They provide free outflow with quick, positive action to prevent backflow. Thousands of these rugged, low-cost gates are serving efficiently on drainage, flood control, land reclamation and irrigation projects over all the world.

Installing Calco-Hardesty Gates is a simple task for unskilled labor. Although usually attached to long lengths of corrugated ARMCO Pipe, they can be adapted to any type of drainage construction. What's more, these gates will serve for years without upkeep or repairs.

There is a size and type of Calco-Hardesty Gate to meet every drainage requirement. Models include automatic drainage gates that open and close without supervision; slide gates for both light and heavy duty; and radial gates for maintaining constant water levels. Write for prices and complete information. ARMCO DRAINAGE PRODUCTS ASSOCIATION, 5020 Curtis Street, Middletown, Ohio.

When open, this hand operated slide gate provides free drainage through a government levee. Closed, it will prevent high water from backing up and flooding adjacent land.

ARMCO

CALCO-HARDESTY GATES

Equipment, Materials, and Methods

New Developments of Interest, as Reported by Manufacturers

New Mobilcrane

AMONG THE NEW FEATURES of the Model 705 WM Mobilcrane, manufactured by The Osgood Co., Marion, Ohio, are: air control of all movements, independent boom hoist, independent travel and swing motions, and hook rollers.

This machine is built to run over rough ground and work under severe conditions without setting up exceptional strains in the mechanism. Other features include:

three point suspension; gear driven transmission with four speeds, ranging from $^3/_4$ to 5 miles per hr; heavy front axle supported in a pintle, allowing up-and-down movement; all six pairs of wheels equipped with air brakes; Twin-Disc clutches; and screw jacks to relieve the tires of excessive weight when making heavy lifts. The Model 705 is also available as an air controlled shovel, dragline, or clamshell with conventional crawler mounting.

Cotton Insulation

WORKING WITH THE Department of Agriculture in its program to develop new uses for cotton, the Reynolds Metals Co. of Richmond, Va., has introduced to the market a new insulation called Reyn-O-Cell, made of water-repellent cotton that has been treated so as to be also flameproof and fire-resistant. Reyn-O-Cell is said to be effective sound-deadening material, adaptable for partitions, floors, and ceilings where sound isolation is desired, with fire-resistant qualities extending far beyond the danger point. Laboratory tests rate this material as being long enduring; free from attack by rats, vermin, and destructive fungi; not subject to decay; odorless, clean, free from dust, and 100% sanitary.

New Paint for Highly Corrosive Conditions

A NEW GRADE of Koroseal paint, named "Koroplate" developed to protect metal surfaces against chemical reactions and recommended for service wherever extremely corrosive conditions disqualify other coatings is announced by The B. F. Goodrich Co., Akron, Ohio.

The new paint, made only in semi-glossy black, is liquid at room temperatures and requires no heating before application. At ordinary temperatures it can be either brushed or sprayed, and can be thinned with either brush or spray thinners when necessary. It must be used in conjunction with a Koroseal primer with similar characteristics.

The new paint when thoroughly dry is extremely resistant to the action of fumes and vapors from acids, alkalies and salts at room temperatures or slightly above. It resists all acids except concentrated formic and acetic, and is not affected by brass, chrome, nickel, cadmium, zinc, copper, silver or tin plating solutions. Such solutions are not contaminated or fouled by the thoroughly dried paint, although it is not recommended for constant immersion in liquids.

Low Head Room Hopper

A RECENT ADDITION to the Gar-Bro line of concrete handling equipment is a double-gate, low head room hopper designed to accommodate the mix from a four cu yd high-dump truck mixer; a side section may be removed to accommodate the dumping of a three cu yd mixer.

The hopper has four wheels, which allows it to be moved from job to job without jacking or the use of blocks. The all-welded steel bin is built bath-tub shape to

insure self-cleaning; double clamshell gates have a clearance of 36 in. Center discharge eliminates segregation. Overall dimensions, 8 ft wide by 13 ft long by 6 ft 3 in. high. Total weight, 3,000 lbs. Manufactured by Garlinghouse Bros., 2416 16th St., Los Angeles, Calif.

Air Compressors

INGERSOLL-RAND COMPANY has announced a line of portable air compressors which are claimed to reduce average fuel costs up to 40 per cent compared to previous I-R models.

In this new line, Ingersoll-Rand offers the first portable compressors available with engines convertible from gasoline to oil or from oil to gasoline operation by making a simple substitution of fuel accessories and without changing heads or pistons. This engine is the Waukesha Multi-Fuel engine built to Ingersoll-Rand specifications. On gasoline it operates as high-economy engine and employs the

same high-turbulence combustion chamber used in the Type H oil engine. It is claimed that this results in a remarkably low fuel consumption, particularly at part loads. On fuel oil, the engine operates like the familiar easy-starting, low-compression Hesselman type.

Another feature is the patented Drill-More Multi-Speed Regulator which automatically adjusts the engine speed to the use of air and practically eliminates wasteful idling while air is being used. This device selects the slowest and most efficient of three working speeds to deliver the required capacity. The machine never idles or wastes gasoline unless the low speed produces more air than is being used. The average working speed of the compressor and engine is thus much less than the rated speed on most portable jobs, thus reducing wear and tear, and lengthening the life of the machine. Many other features are fully described in new catalogs. Ingersoll-Rand Co., 11 Broadway, New York, N.Y.

Tractor Lubricant

DEVELOPMENT OF A viscous track roller lubricant for crawler type tractors, which is also suitable for army tanks of similar mechanism, is announced by Standard Oil Company of Indiana. The new product protects against dirt and other contaminants, has high resistance to water, and has a consumption ratio 20 to 25% lower

Literature Available

CIRCUIT BREAKERS—Two classes of Oil Circuit Breakers are described in Catalog No. 3650, and another type in Catalog No. 3940. Roller-Smith Co., 1766 West Market St., Bethlehem, Penna.

CLAM SHELL BUCKET—A bulletin just published by The Hayward Co., 50 Church St., New York, N. Y., describes in detail the new Hayward Class K-6 Digging Type Clam Shell Bucket, for excavating earth, compact sand, gumbo, gravel, and other similar materials.

CONCRETE MIXERS—The Ransome Concrete Machinery Co., Dunellen, N. J., has announced the issuance of a new eight-page, two-color bulletin, No. 177, illustrating and describing 14-S Mixers.

CONTRACTORS TOOLS—A new catalog, No. 42, of Thor Mining and Contractors Air-Powered Tools has been issued by the Independent Pneumatic Tool Co., 600 West Jackson Blvd., Chicago, Ill. It contains descriptions, specifications and applications of all Thor rock drills, paving breakers, clay and trench diggers, sump pumps saws and associated air tools.

CRAWLER CRANES—Bulletin No. X-78 covers P&H cranes with capacities from 50 to 60 tons, with supplementary material on truck cranes, switcher cranes, and other specialized equipment. Harnischfeger Corporation, Milwaukee, Wis.

CRUSHERS—Catalog D-41-G illustrates and describes the modern, self-contained Diamond portable crushing and screening plant. Diamond Iron Works, Inc., Minneapolis, Minn.

DIESEL POWER—"What Users Say About Caterpillar Diesel Power" is an attractive 16-page booklet published by Caterpillar Tractor Co., Peoria, Ill.

EARTHMOVERS—The entire Le Tourneau line of construction equipment is covered by pictures, descriptions, and specifications in the 48-page, 1941 catalog, Form A-11. R. G. LeTourneau Inc., Peoria, Ill.

LIQUID LEVEL GAGES—Float, pressure-bulb, pressure, air-bubbler, counter-poise and differential pressure type water and liquid level gages are described for all types of applications in Catalog 1015. Bristol Co., Waterbury, Conn.

MOTORS—Heavy duty motors—1 to 60 hp and 50 to 300 hp—are described in Bulletin GEA-1542 D and GEA-1868 B respectively. General Electric Co., Schenectady, N.Y.

PUMPS—Improved Peerless Hydro-Foil Pumps are described in a new bulletin, No. 148, issued by Peerless Pump Co., 301 W. Ave., 26, Los Angles, Calif.

ROAD BUILDERS—The use of modern roadbuilding and construction machinery in the progress of states, counties, cities, and towns, is described in a 20-page booklet, Form No. 6531, issued by Caterpillar Tractor Co., Peoria, Ill. Motor graders, tractors, and Diesel engines are illustrated on a variety of jobs showing the ability of a single modern construction machine to economically perform a quantity of tasks.

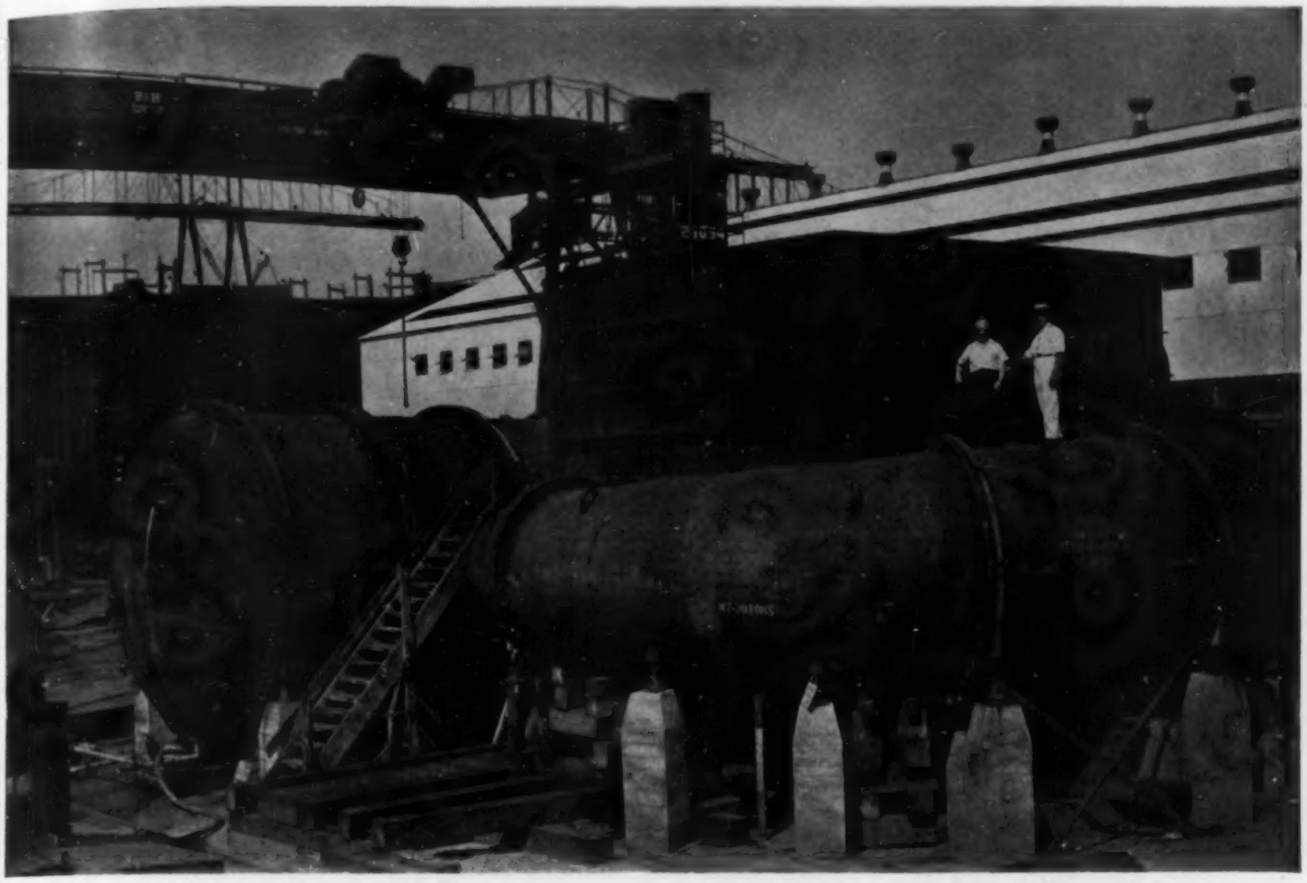
SHOVELS—A new catalog describing Type 80, Model 800 Air-control Shovels, Draglines, and Cranes sets forth how the Model 800 is built, and how Air-control works. Catalog No. 4102. The Osgood Co., Marion, Ohio.

SOUND LEVELS—A new booklet, in non-technical language, on the subject of sound levels and related factors governing selection of axial flow fan units, has been published by the De Bothezat Ventilating Equipment Division of American Machine and Metals, Inc., East Moline, Ill.

SPOT WELDING TIMERS—Ignitron spot welding timers to control welding of aluminum, heat treated alloys, and other materials are described in Leaflet No. 18-335, announced by Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penna.

TESTING MACHINES—A new 40-page bulletin, "Southwark-Tate-Emery Testing Machines and Allied Equipment," published by Baldwin-Southwark Div., The Baldwin Locomotive Works, Philadelphia, Penna., contains more than 50 photographs and charts picturing the Company's testing machines in capacities from 20,000 lb to 4,000,000 lb. Subjects under test include, among others, airplane wing sections and engine mounts, riveted joints, gears, girders, and concrete blocks.

WELDING—A comprehensive 36-page booklet on the Thermit welding process and its applications may be obtained from Metal and Thermit Corporation, 120 Broadway, New York, N.Y.



Belt Conveyor Idler

A TROUGHING TYPE rubber-tread impact idler, designed to absorb the shock of receiving heavy, lumpy, rough materials at the loading point, is announced by Link-Belt Co., Indianapolis, Ind.

It is pointed out that the cushioning effect of the rubber-to-rubber contact between belt and idler will prevent cutting, bruising, scuffing of belt and protect the bearings and framework from shock. Other features claimed for the new idler,

which is available for belt widths of 12 to 60 in., are: less breakage of fragile material such as coke, friable coal, etc.; cleans the belt and prevents building up of material; withstands corrosion and abrasion.

New Midget Welder

FOR USE IN WELDING light gage metal, castings and drive shafts, general maintenance, and light production work, a new Flexarc welder is announced by Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penna.

Known as the Midget Marvel WT-1, this a-c welder comes complete with all accessories, including the primary cable for hooking up the power line, electrode lead and holder, work lead, helmet, and a supply of electrodes. Sensitive adjustment of the welding current over a range from 20 to 140 amperes is provided by 15 steps with correctly proportioned increments between steps. Full load rating is 110 amperes, 30 minutes, 30 load volts,

when used on 220-volt, 60-cycle lines. The cost of power consumption is said to average about 5 cents an hour depending on local power rate. Approximate dimensions are $14^1/_2$ by $12^1/_8$ by 20 in. long. Weighing 160 lbs., the welder is supported on casters to facilitate mobility.

New LeTourneau Equipment

TWO MODELS have been added to the LeTourneau line of earthmoving and construction tools—the Tournacrane and another extra-capacity Carryall Scraper.

The Model FU Carryall cable-controlled scraper, a patented double-bucket model with a struck capacity of 17.7 and a heaped capacity of 23 cu yds, is designed to give increased yardage with D8 tractor power. Its ability to work efficiently

either with or without a pusher tractor makes this machine adaptable either to long or short hauls and to operation singly or in fleets. The double-bucket feature gives the effect of loading two small Carryalls one after the other; the rear bucket telescopes forward and is loaded separately; after the first bucket is loaded to capacity, it travels back on rollers and roller bearings instead of being forced back. In order to make the Model FU adaptable for all types of job conditions, it may be equipped with a large variety of tire sizes.

The Tournacrane is built to combine the speed of a Tournapull and the lifting power and maneuverability of a tractor crane. Boom lengths of 20, 30, and 40 ft and a lifting capacity of 10 tons fit this equipment to a wide variety of jobs such as unloading flat cars, erecting steel, stacking material in warehouses, placing concrete

reinforcement on paving jobs and similar handling of large, awkward, and heavy loads. One of the main features of the Tournacrane is its easy interchangeability with other Tournapull tools, so that only one power investment is necessary to handle lifting, hauling, and earthmoving jobs.

Roller Gate Concrete Bucket

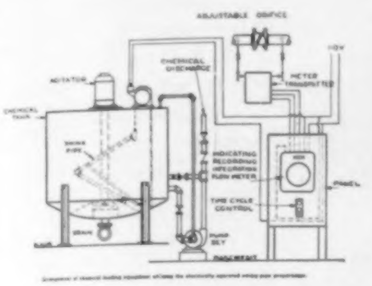
A ROLLER GATE BUCKET which will receive a concrete charge either in upright position or lying down, known as the Hi-Lo charge model, has been developed by Blaw-Knox Co., Pittsburgh, Penna., and is described fully in their Catalog, No. 1816.

The Hi-Lo bucket has a receiving hood and skids which permit laying it down to receive its full rated load from a truck mixer. When lifted, the bucket assumes its normal upright position for discharge. It is available in 1, $1^1/_2$, and 2 cu yd sizes, and is a single-line type.

Electrical Controls for Chemical Feeders

The Cochrane electrically operated chemical proportioner has been developed particularly for proportioning a number of individual chemicals to water conditioning systems.

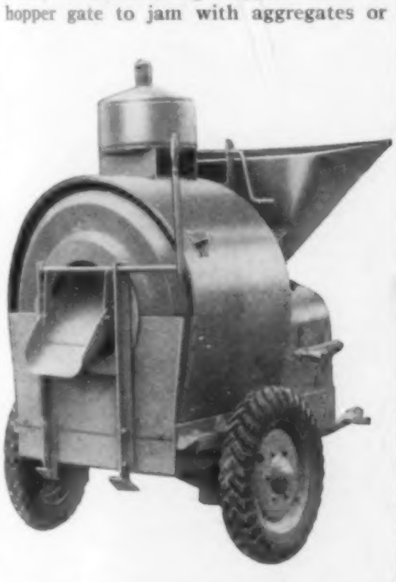
In this combination a swing-pipe chemical proportioner is controlled from a Cochrane electric flow meter provided with contacts on the integrator train. When the predetermined quantity of water has



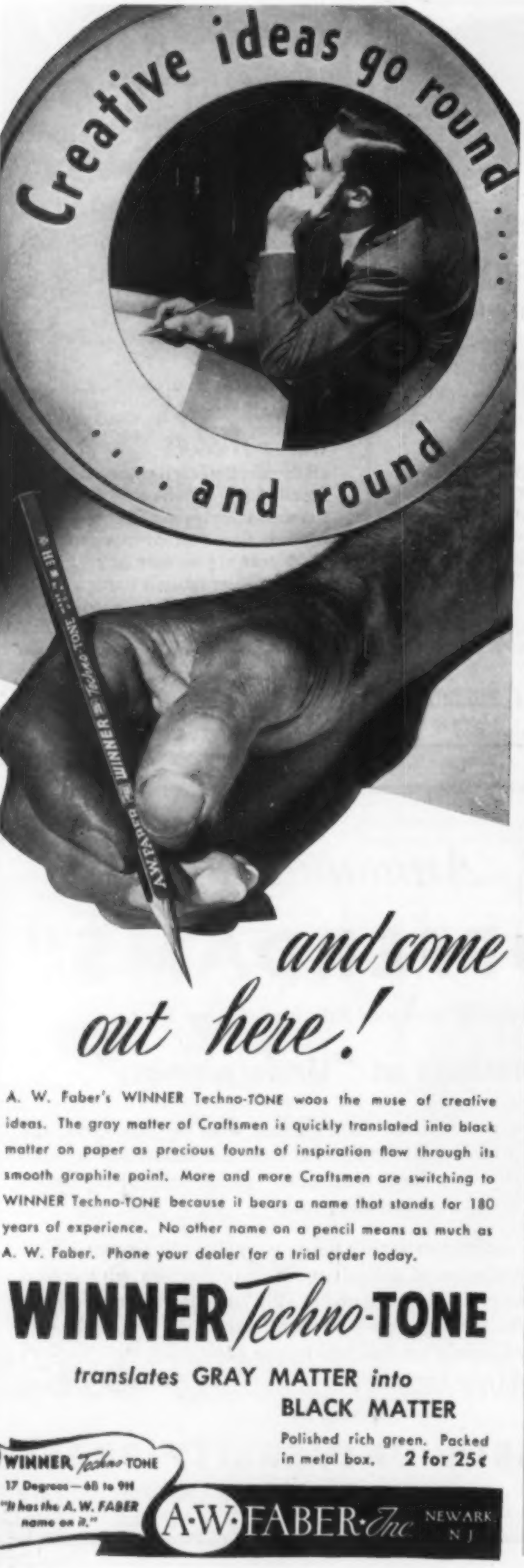
passed through the meter orifice, the integrator closes a contact in the electrical circuit, including a time-cycle relay. Details of proportioner design and construction, and applications, are described in detail in Publ. 3015, issued by Cochrane Corp., Philadelphia, Penna.

Non-Tilting Mixer

The $3^1/_2$S skipper, a non-tilting mixer recently introduced by Chain Belt Co., Milwaukee, Wis., has a 6-in. lower shoveling height which is said to cut as much as five miles of shoveling in five days of work; a self-cleaning hopper with no hopper gate to jam with aggregates or



cement; a shimmy hopper control which makes sticky material flow freely into the drum; die formed pressed steel drum heads and polished drum tracks; and a Rex chain belt drive. This is an end discharge mixer mounted on two pneumatic tired wheels, equipped with a $3^1/_2$-hp air cooled motor, and can be furnished with or without water tank.



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